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ABSTRACT

This unit is part of a series of materials produced by a project to develop locally applicable class, lab, and field materials in ecology and social studies for Guam junior and senior high schools. While the materials were developed for Guam, they can be adapted to other localities. The unit stresses the uniqueness of natural Guam, especially the plants and animals. The changes that occur in the natural life also receive emphasis. Seventeen activities are included. (RH)

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Life On Guam
Savanna, Old Fields, Roadsides

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SE 021 732

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Life On Guam

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"....to ultimately graduate citizens who are knowledgeable and conscientious about environmental concerns of Guam and the rest of the World."

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Suggested Materials; A Packing Crate Lab; Plants Endemic to Guam and the Marianas; Pre-European Introductions; Crops Introduced from the Americas by Spaniards; Introduced American Weeds; Acknowledgements; References

To Students

This unit was written to let you know what's going on here. The main things to find out about are:

1. The uniqueness of natural Guam, especially our plants and animals, as contrasted to the general aspects of life on Guam.
2. That natural life on Guam is very dynamic—always changing.

We'd like you to enjoy learning about Guam's savanna, old fields and roadsides. Please do this, and

1. Keep a good notebook, and
2. participate in class activities.

Keep in your notebook everything to do with this unit. Make it good so that you can keep on referring to it in years to come. Do as many of the exercises as possible and record the results. Design some experiments or go on some fieldtrips of your own, and keep their results as well.

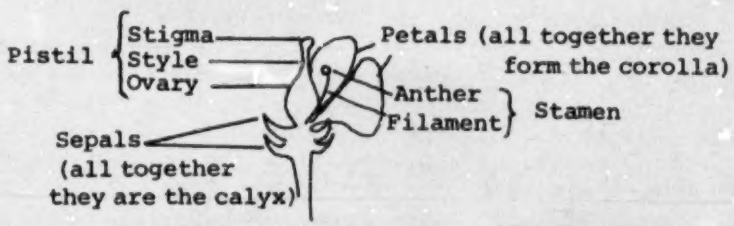
Class participation means discussing, sharing what you've learned, preparing displays, etc. Concentrate on learning and the earning will follow.

Good luck, good learning!

Some Botanical Terms

Of the many terms botanists use every day, here are a few for you:

Flower—the reproductive organ of many plants.



Inflorescence—a group of flowers together on one stem:

Leaves:

2

Endemic—found only in one area. Some plants are endemic to Guam—they grow only on Guam and nowhere else in the whole World! Other plants are endemic to the Marianas—found only on these islands.

Indigenous—native, belonging naturally. Plants indigenous to Guam might be called 'real Guam plants'.

Introduced—brought in, on purpose or by accident.

Invader—an introduced species which spreads rapidly and replaces native ones.

Herb—generally a small, soft plant; sometimes a big soft plant, like a banana 'tree'.

Shrub—a woody plant smaller than a tree. If it has lots of branches we call it a bush. If it has few branches and stands straight up, it's an erect shrub.

A Word On Names

A plant or animal on Guam may have three names: the local Chamorro name, an English name, and a scientific name. The Chamorro and English names may not be well known. Many native Guam plants don't have English names. Some introduced plants don't have local names because they haven't been here long enough to acquire them. Scientific names are known to scientists all over the World. They will make it possible for you to look up more information on the plant or animal concerned.

Scientific names have two parts, the genus and the species. The first tells what group the plant belongs to, and the second identifies exactly that kind of plant. The namer's name follows these two. (If you want to know who named a certain plant, look it up in The Flora of Guam by Benjamin Stone.)

Here's an example: Guam's official flower is puti tai nobiu, bougainvillea, Bougainvillea spectabilis Willdenow. The Guamanian name of the plant means "It hurts not to have a boyfriend". The English name is bougainvillea, after Louis Antoine de Bougainville, French navigator. The scientific name tells us it belongs to the genus Bougainvillea and the species spectabilis. Both are underlined and the genus name is capitalized. A second way to write a scientific name is in italics, *Bougainvillea spectabilis* Willdenow, without underlining.

We'll give you all the names of a plant at first mention, and after that refer to it by the name which seems best known. If the scientific name is used over and over, it will be spelled out the first time but the genus name will be abbreviated the next times it appears. For example, if we mention the scientific name for puti tai nobiu again, it will appear as B. spectabilis.

3

In this unit we will look at Guam's open areas. Some people may pass off savanna, old fields and roadsides as 'just grass'. We will find, however, that a lot of interesting plants and animals are there. Also, a lot is going on.

Guam's old fields and roadsides are constantly changing. If we can only learn to look, it's like a moving picture going on before us. In this unit we will contrast the savanna community with man-made old fields and roadsides. We will also discuss natural succession and invasions by foreign plants and animals.

Savanna

If you ever need a peaceful pause, if you ever need to forget your problems for a time, go to a savanna. Lie under an ironwood tree, (that's gagu, Casuarina equisetifolia). Close your eyes. Listen to the wind through the ironwood 'needles'. Hear the 'sounds of silence'. In Guam's savanna country you can almost feel the Earth breathe. Look out across the grass-covered hills. It's

the biggest view of a Guam without houses, cars, buildings, smoke and noise that you can get. Lie on your belly with your hands cupped under your chin. Gaze out across the hills and valleys. Feel the Earth's contours. Look up at the clouds that float along over Guam. It's all so big and magnificent. It puts us into perspective as creatures of the Earth-Island.

If we look at the savanna with understanding we can appreciate it even more. It is a community of unique plants adapted to Guam's volcanic soils, and one tall grass especially adapted to the frequent fires that sweep this area.

Generally the term 'savanna' is used for flat plains with grass and scattered trees. On Guam, however, the area we call savanna is not flat and often there aren't many scattered trees. I don't know of a better word to use in talking about the area as a whole, so we will follow the botanists before us and continue calling the area 'savanna'. The local name is 'sabana'.

Savanna Subtypes

In savannas there are four distinct types of vegetation:

1. Swordgrass (nette, Miscanthus floridulus) grasslands——These may be almost pure stands of dense swordgrass with a few scattered ironwood and Pandanus (kaffo') trees. This community is very common in Guam's southern hills.

2. Dimeria grasslands——These are patches of a soft low grass often mixed with sedges and some of the species of the mixed shrub community.

3. Phragmites (karisu, reed) swamps—— Dense stands of tall reeds are found in low marshy parts of savannas. They're also found in other places, like Agana Swamp.

4. Mixed shrub community——This is the most interesting patch of savanna country. The plants that grow in patches of open area are beautiful and almost all endemics (found only

in the Marianas or maybe only on Guam, and nowhere else in the whole World), or indigenous (natural to Guam but also found elsewhere). There aren't many places where you'll find them all growing together. You'll find them mostly scattered here and there alone or in small groups.

Environmental Factors

In the next section, we'll look at the individual plants that make up the savanna. First, let's consider some general things about the area.

There is a great deal we don't yet understand about Guam's savanna. Some things that we do know are:

1. The savanna lives on old volcanic soils. These soils are heavy and claylike. In the wet season they absorb water and are very muddy. After extended dry periods they dry out, at least on the surface. Then they get hard on the surface, and crack. Do the cracks make a pattern? These soils are generally acid.

2. Burning happens on the savanna. When the tall swordgrass is dry, it burns easily. It burns right down to the ground but the roots remain alive. Soon after an area burns over, the swordgrass sprouts again. Frequent fires favor swordgrass over trees, killing small trees but not swordgrass. The more the area is burnt, the more nearly pure grow the stands of swordgrass.

Early Guam man probably helped swordgrass along. He didn't have any metal cutting-tools. Fire must have been used a lot to clear land to plant crops. Archaeologists tell us that one of these crops was rice. While other original Guam crops could be grown in a mixed forest, rice requires an open area. This means clearing. Clearing means fires. Fires favor swordgrass.

Present-day arsonists (people who start fires) continue to help keep our southern hills covered with swordgrass rather than mixed vegetation and forests.

6

The Effect of Fires

The mixed shrub and Dimeria communities of Guam's savanna country are interesting and unique. These communities aren't very common. Swordgrass lands are very common, too common. It might be good if we could convert some of Guam's swordgrass lands into areas with more varied and useful vegetation. This would reduce the soil degradation that results when fires burn off swordgrass and leave the soil exposed to sun and rain. The conversion of some swordgrass lands would provide more valuable tree species and better habitat for a wide range of animals. It might also provide more pleasant recreation places for people.

There are a number of ways to help change a swordgrass land to forest. One is to protect the area from fires. In this way you encourage the growth of trees. This appears to have happened in the Fena Lake area of Naval Magazine, protected from fires for many years. When a cleared forest area is protected from fires, it begins to reforest naturally with local species from nearby ravine forests. The process can be speeded up by helping the local trees to grow, or by planting more of them.

On Guam there have long been laws against starting grassfires, but there has been little enforcement of these laws. Hunters start grass fires to remove tall swordgrass. The 'Guam deer', actually the Marianas elk, Cervus mariannus, (this little elk was introduced from Malaysia via the Philippines a long time ago) is thus encouraged to come out and feed on the new tender shoots of the burnt swordgrass. This makes the deer easier to see and shoot.

Some fires start when people toss lighted cigarettes out of car windows. The growth of a fence of relatively fire-resistant tangantangan along the coral roads helps to cut down on grass fires caused this way, though.

Some people deliberately start grassland fires just to see them burn. A just reward for these people would be to make them live in the swordgrass land that they are helping perpetuate!

Forestation Programs

The Navy began an experimental forestation program about 1968. Soon afterwards federal funds became available to the Government of Guam for similar work. In 1970, the Guam Department of Agriculture began a forestation program. The present program involves the planting both of local species of trees and many introduced species like teak, kukui and guava. Many of the plantings are doing well. One area to watch is the nature reserve along Cross-Island Road. This area was set aside so that a good example of a mixed shrub community could be preserved for study because of its uniqueness. Forestation plantings have been made in the area. In addition, coral has been laid down in the road to part of the reserve. Coral is alkaline. This will change the pH (degree of acidity) of the soil in the area. This may help other plants to grow there. The road will make the area more accessible to people. We now have one more place to watch the struggle of old and new Guam.

Motorcycles and Savanna

Guam's southern hill country is a favorite spot for motorcycle hill climbing. It's fun riding the contours of the hills. The clay soils are a little soft and don't tear you up like the coral rock of northern Guam when you fall. The area is also kind of clear, nice for riding bikes.

Unfortunately, the passage of many motorcycles makes an area clearer and clearer and clearer. Motorcycle tires kill plants and leave tracks in the clay. When it rains, the tracks are eroded (the soil washes away) into gullies. The more it rains, the deeper the gullies get. The soil washes down into rivers, and then into the ocean. The land is made poorer and the sea gets polluted with mud.

If you're a bike freak now or in the future, remember this—if you must shatter the silence with the roar of your engine, leave some quiet places for creatures that like quiet. Confine your bike riding to established areas. Don't go off into new ones. Someday you may change from a bike freak to a Nature freak. Leave yourself some possibilities for the future!

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Some Savanna Plants

Miscanthus floridulus

Indigenous Nette, swordgrass

This is a tall grass that grows in clumps about 3 meters high. The clumps may grow in almost pure stands. Sometimes there are a few scattered ironwood trees. Swordgrass is adapted to fires. When it is dry, it burns easily. Burning doesn't kill it, though. The roots are still alive and soon sprout and the tall grass grows again.

As you might expect from its name, sword-grass has sharp edges and you may be scratched and cut in trying to get through it. All that cuts is not swordgrass, however. One sedge (a grass-like plant with razor-sharp edges) scratches and cuts even better.

At one time, swordgrass was used for thatch.

In recent years, a very interesting thing has happened. Swordgrass has a competitor! This is Pennisetum setosum, the yellow-tailed grass once a common weed of limestone areas in northern Guam. It seems like the wind kept blowing it, seed first, southward. It showed its adaptability by traveling from limestone soils right into savanna soils. Now, when a fire burns off the swordgrass and Dimeria, Pennisetum jumps in. It grows fast and sets seed fast. One day it might be a dominant grass of Guam's southland.

Phragmites karka

Indigenous Karisu, reed

Phragmites is a tall reed (a large grass-like plant with hollow stems). It looks something like swordgrass but grows in low wet areas. Swordgrass grows on slopes and ridges. When you see Phragmites you can bet there is water or mud below it.

Phragmites isn't really a 'savanna plant'. It is very common in Agana Swamp and along rivers. I'm including it here because you may run into it around savannas.

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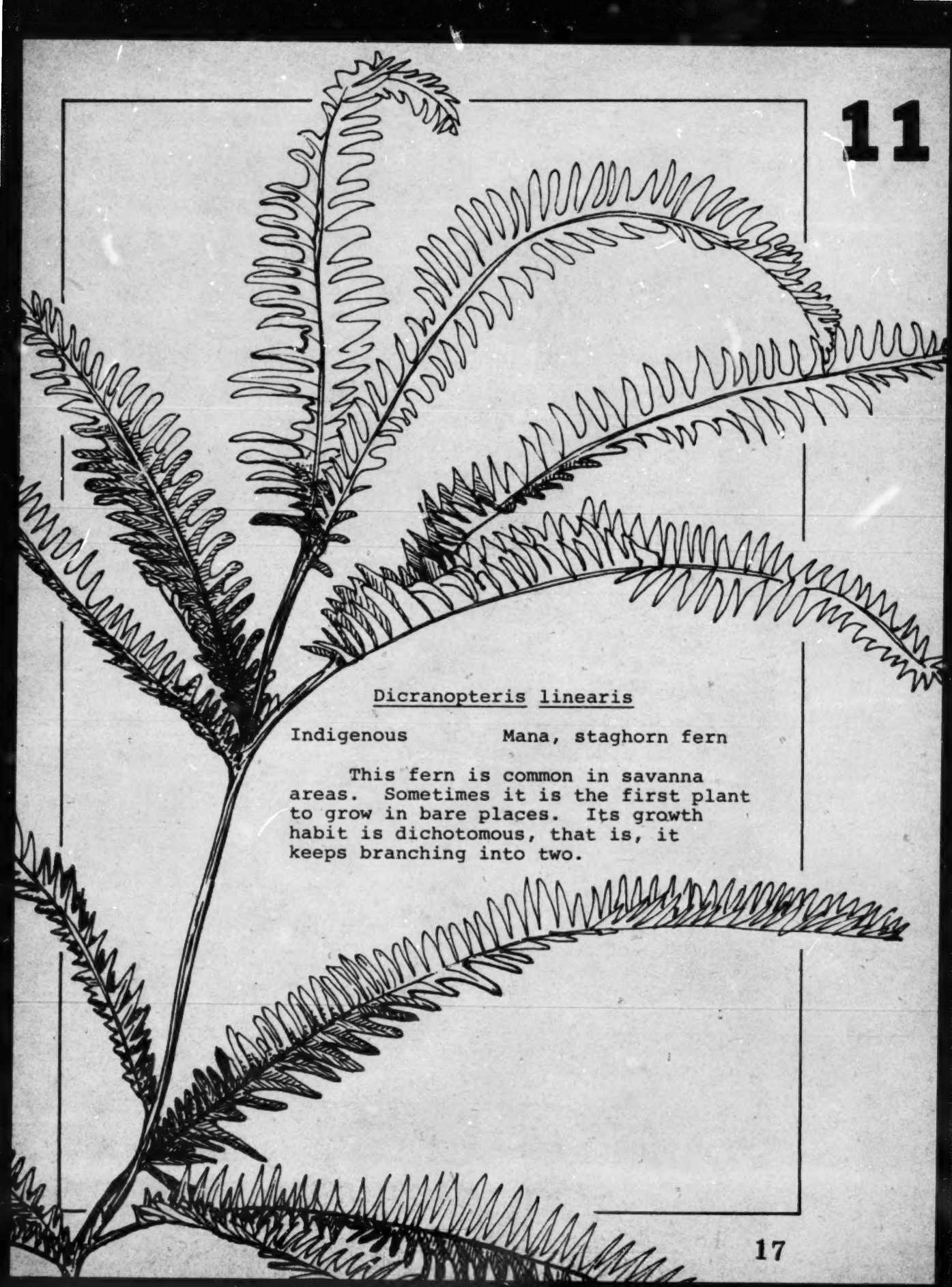
Dimeria chloridiformis

Endemic

Dimeria chloridiformis is an endemic grass. It is low-growing, bluegreen, and very hairy. The hairs may sometimes be a little longer along the edges of the leaf. In the middle, though, they are all about the same length. This makes the leaf feel like velvet. Touch it against your cheek or lips and feel its softness.



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Dicranopteris linearis

Indigenous Mana, staghorn fern

This fern is common in savanna areas. Sometimes it is the first plant to grow in bare places. Its growth habit is dichotomous, that is, it keeps branching into two.

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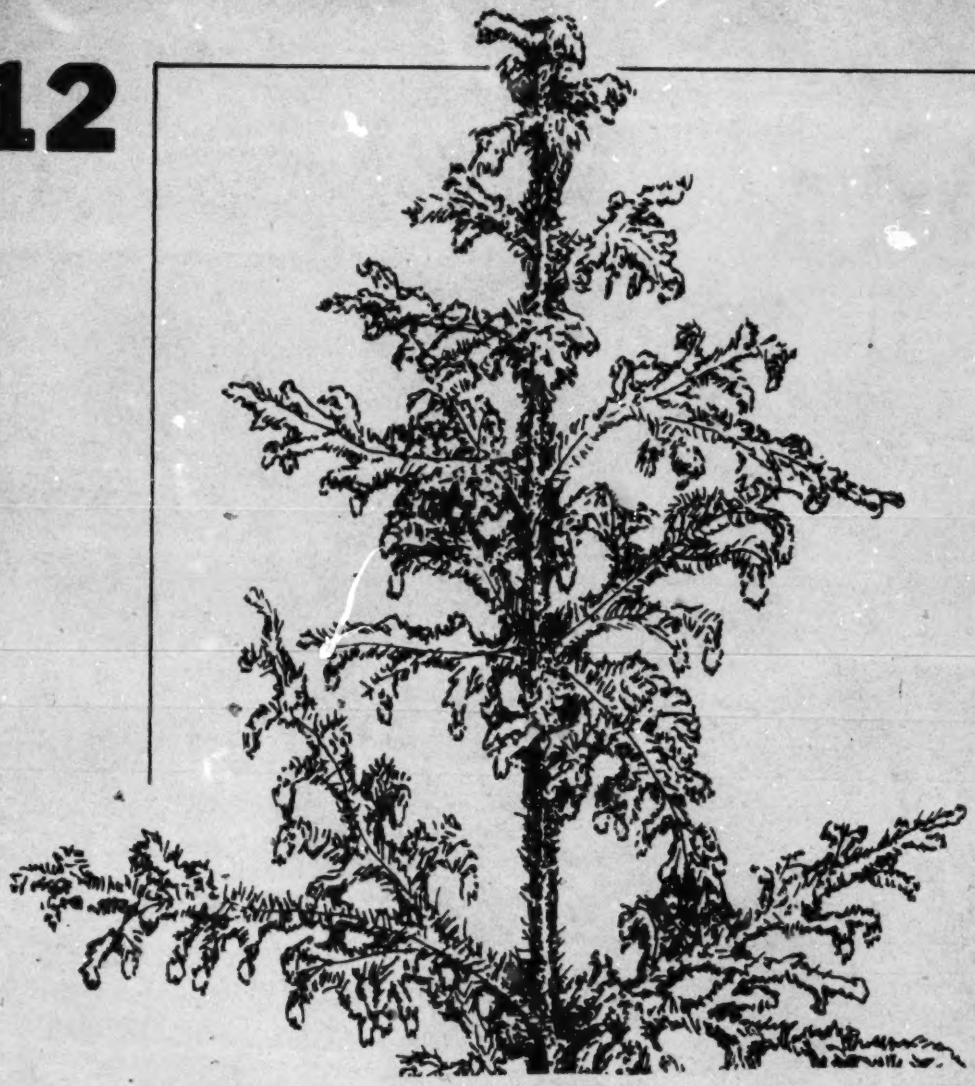
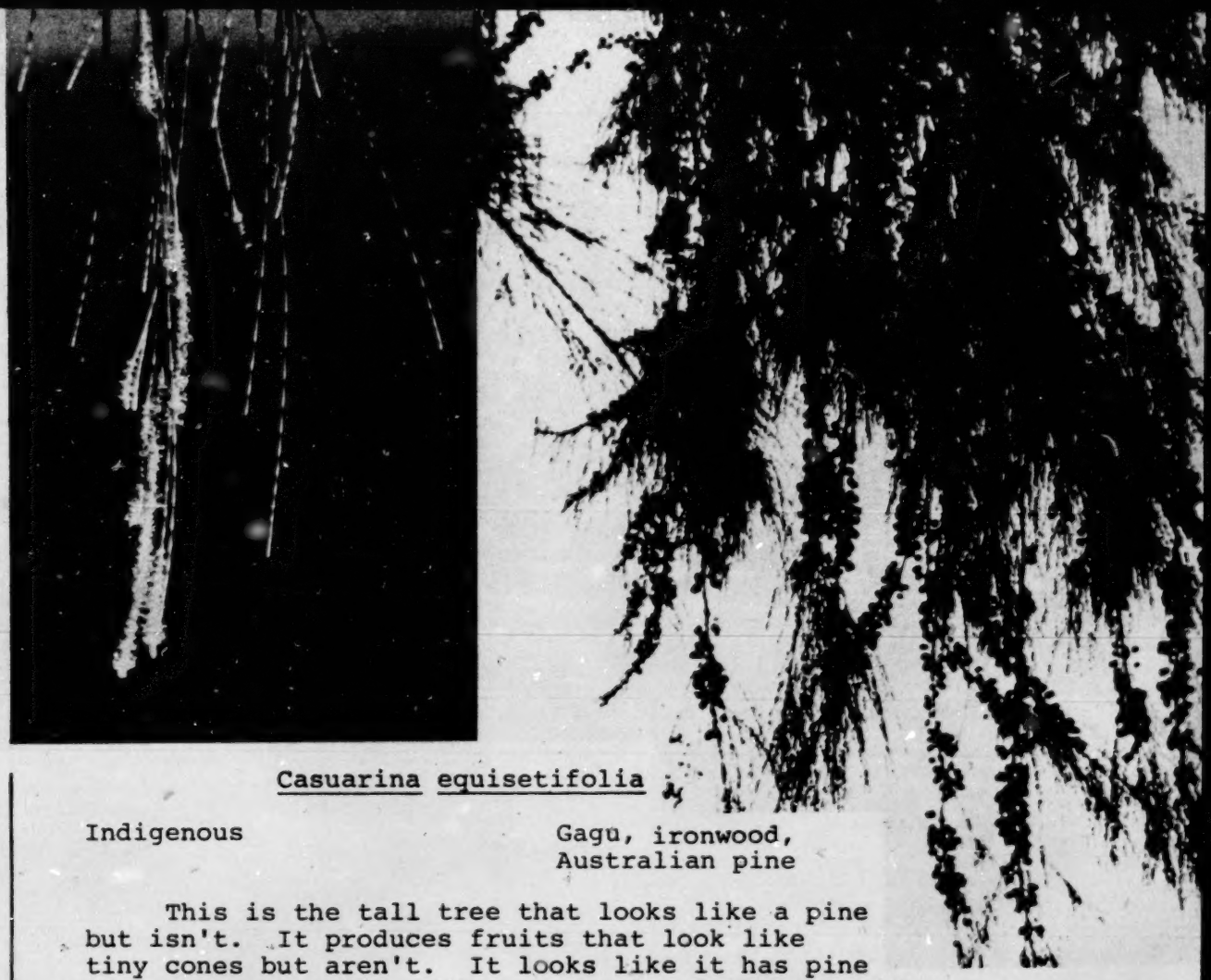


Lycopodium cernuum

Indigenous, pantropical Patas nganga' (duck foot)

The generic name of this plant means 'wolf foot'. This refers to the strobili (fruit bodies) at the tips of the branches. They look like wolf paws. Sometimes when you shake the plant you'll see a cloud of yellow dust. This is thousands of tiny spores. Each one can grow into another tiny plant that lives under the ground. This plant produces male and female parts that produce the zygotes (very young embryos) that grow into the big plants we see.

Our Lycopodium has several forms. Sometimes it grows erect like a little Christmas tree. At other times it crawls along the ground.



Casuarina equisetifolia

Indigenous

Gagu, ironwood,
Australian pine

This is the tall tree that looks like a pine but isn't. It produces fruits that look like tiny cones but aren't. It looks like it has pine leaves but doesn't. It's an example of convergent evolution——unrelated species in different parts of the World developing into similar-looking plants or animals. The genus Casuarina evolved in Australia. Australia is a big island which has been separated from the other continents a very long time. Many unique forms of life evolved there. Casuarina is just one example.

Actually, Casuarina is a flowering plant. What look like pine needles are really green branches. The true leaves are tiny triangles that circle around the joints of the branches.

The wood of this tree is very hard——that's why it's called ironwood.

The ironwood tree is pretty hardy. It can withstand fires to some degree and can be found scattered in swordgrass fields.

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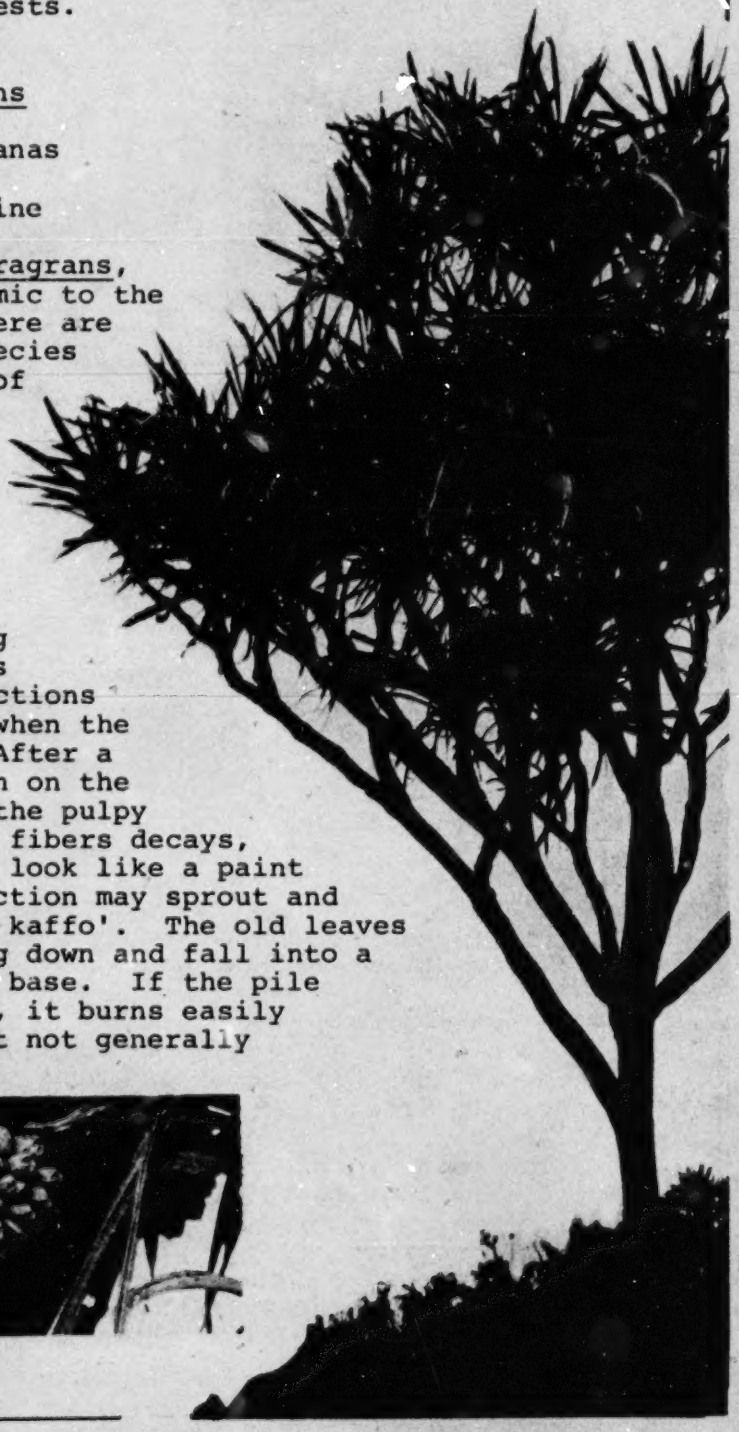
Ironwood is found in other places besides savannas, including beaches. It grows almost everywhere on Guam and can be kept trimmed into hedges. When it grows in thick stands where there isn't too much wind, it is a favorite spot for wasps to make their nests.

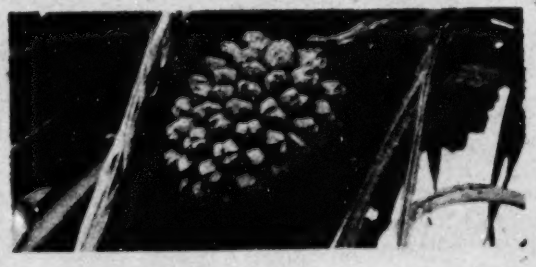


Pandanus fragrans

Endemic to Marianas

Kaffo', screw pine

Pandanus fragrans, kaffo', is endemic to the Marianas but there are very similar species in other parts of Micronesia. You're probably familiar with this tree with the spiny leaves and prop roots. The fruit is big and round. It's made of many sections which fall out when the fruit ripens. After a section has lain on the ground awhile, the pulpy part around the fibers decays, making the husk look like a paint brush. Each section may sprout and grow into a new kaffo'. The old leaves of the tree hang down and fall into a pile around the base. If the pile catches on fire, it burns easily and brightly but not generally



hot enough to kill a tree. Sometimes the white tern, chunge', lays its eggs in kaffo' trees. If the tree is tall enough, these eggs may not even be affected by a savanna fire.

Kaffo' doesn't grow only in savannas. It is also found in ravine forests and limestone forests where the other Guam species, Pandanus dubius, pahong, grows. This has bigger leaves than kaffo' and often a shorter trunk.

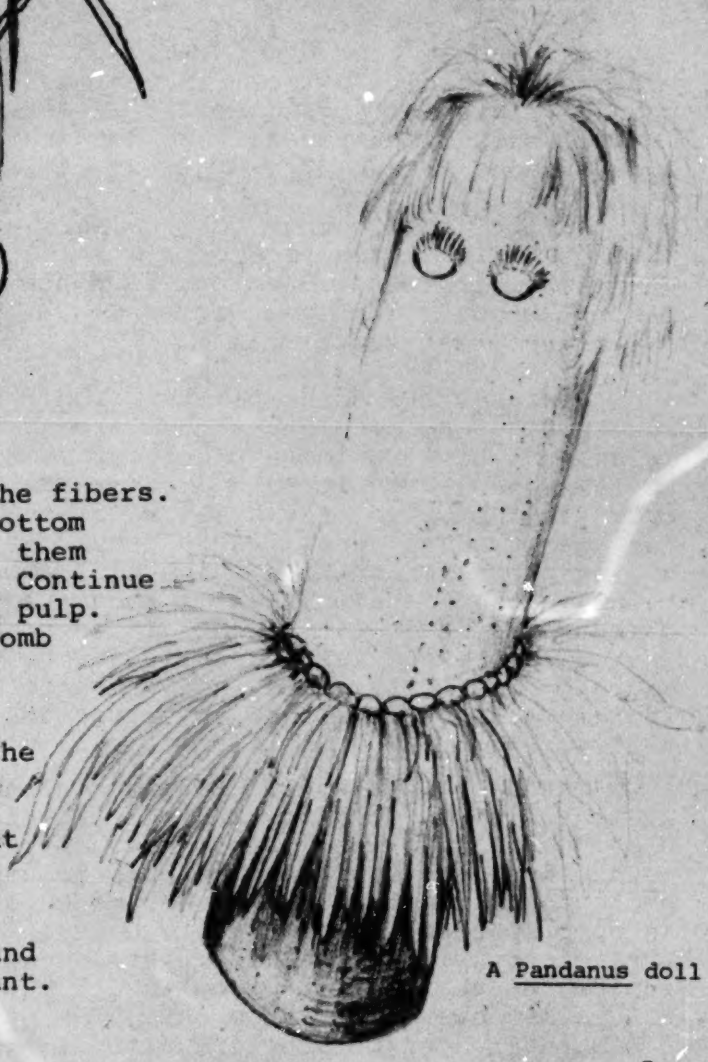
Pandanus are hardy plants. Their seeds float and this has helped to get them around to many islands. They provide a place for some birds to lay eggs. Mosquitoes and other small animals breed in the water that collects at the base of the leaves. The dense leaves provide a good hiding-place for geckoes which eat, among other things, mosquitoes. The prop roots provide a place for lizards to get out of the grass and sit in the sun. Ripe kaffo' sections were probably eaten by fruitbats in savanna areas before the fanihi were hunted almost to extinction.

Pandanus is a useful tree to islanders, too. It is sometimes used for thatch. The leaves are also useful as a weaving material after they have been properly prepared. The pulp around the ripe sections of the fruit is sweet and good to eat in some species, but in others contains too many irritating calcium oxalate crystals. The seeds inside the sections are good to eat but you'll need a machete to get them out. They taste like a combination of coconut and almonds——good!

There are a number of species and many varieties of Pandanus in the Pacific. They are especially variable in the Marshall Islands where people have cultivated them and developed many forms that are specialized for such things as fine leaves for weaving, extra thick sweet pulp, or large seeds.

You can make a doll out of a Pandanus prop root. Find a new prop root that hasn't yet reached the ground. Cut it off about 45-50 cm from the tip. Gently pound the two ends of this piece. Squeeze out the juice. Continue pounding and squeezing or chew on the root until pulp is

removed from the fibers. Separate the bottom fibers and tie them to form legs. Continue to chew on the pulp. Then you can comb it out into flowing hair. Carve or draw a face under the hair and pull up fibers for eyelashes. Cut out and pound sections from the sides to form a skirt and arms if you want.

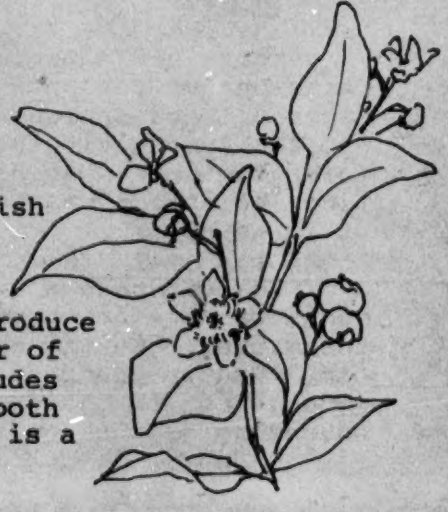


A Pandanus doll

Decaspermum fruticosum

Indigenous

This is a small shrub with pinkish new leaves covered with silvery hairs. The flowers are small, white to pinkish, with many stamens (the male parts which produce pollen). This plant is a member of the Myrtaceae family which includes Myrtella (p. 18). Notice that both plants have many stamens. This is a characteristic of the family.



Hyptis capitata

Introduced Batunes

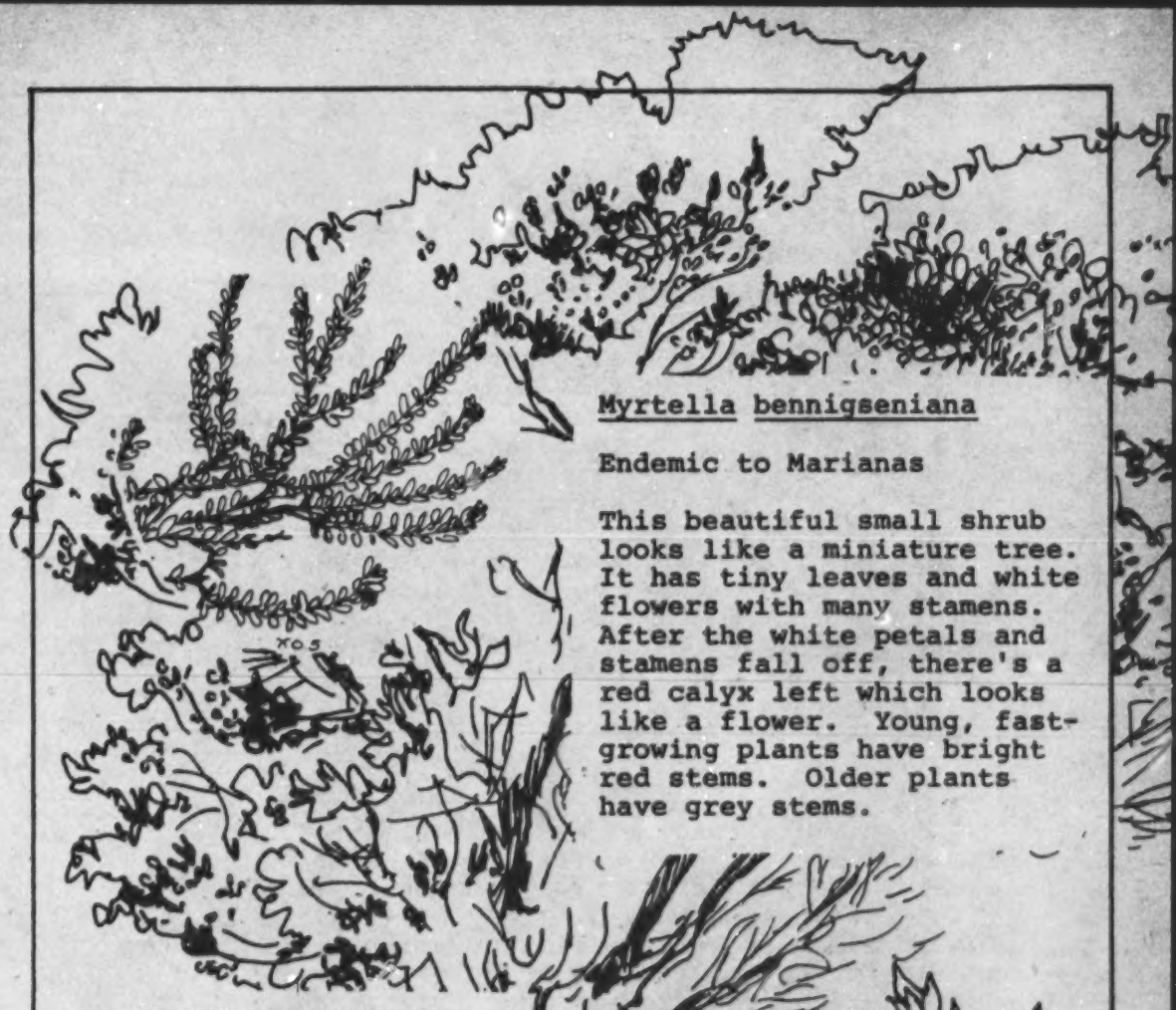
This erect weed is common in savannas. Not originally from Guam, it's an American invader. Its equipment for invading is the production of a lot of seeds that sprout fast, and especially its hardy rootstalks. It grows anew each year from the rootstalks, even sprouting again after it has been cut down or burnt.

Hyptis capitata belongs to the mint family. Like many plants in this family, it has opposite leaves (directly across from each other) and square stems. It doesn't have a strong minty smell though, like some members of the family. Look around in the savanna for other plants with opposite leaves and squared stems, and flowers (not inflorescences, though) like Hyptis. Smell them, you may be pleasantly surprised! The sage that your mother may use in cooking is also a member of the mint family.

Hyptis flowers are clustered in a round inflorescence (many little flowers together). The flowers are white. After they fade and fall, the brown calyces (bottom parts of the flowers) remain and dry into a round 'button', used in making dry flower arrangements.

Batunes is very common in some places and when in bloom it attracts beautiful égigi, the cardinal honey-eater. After the flowers are gone and the seeds form, it attracts the little rice manikin and sparrows which eat the seeds. So, where there's batunes, there's likely to be a peeping and flutter of little birds.

18



Myrtella bennigseniana

Endemic to Marianas

This beautiful small shrub looks like a miniature tree. It has tiny leaves and white flowers with many stamens. After the white petals and stamens fall off, there's a red calyx left which looks like a flower. Young, fast-growing plants have bright red stems. Older plants have grey stems.

Timonius nitidus

Endemic to Guam

Maholok layu,
Sumak ladda

This is a large shrub or small tree. Leaves are dark with a lighter midrib. Older leaves are purplish. Flowers are cream to yellowish. The ripe fruit is dark purple. The plant is a member of the coffee family.

Geniostoma rupestre

Indigenous

Maholok hayu, nanasu

A woody shrub to a small tree. The leaves are dark, 6-14 cm long. The flowers are white with hairs in the center. If the plant has ripe fruit it's easy to identify because the fruit opens to display the bright red seeds.

Phyllanthus saffordii

Endemic to Guam

This is a small or medium-sized erect (say, 50 cm tall) woody shrub. The leaves grow from each side of bending branches at the top of the plant, like a tiny coconut tree. The tiny flowers and fruit are borne under the branches. The fruits are rounded and have six grooves.

20

There are 8 species of Phyllanthus on Guam. The biggest is P. acidus; its fruit is the iba, which you may know. The fruit of P. saffordii looks like tiny ibas.

This only-on-Guam plant was named after the aide to the military governor at the turn of the century, Lt. William Safford. This brilliant man was among other things, a botanist, and wrote the book, Useful Plants of Guam.

Wikstroemia elliptica

Indigenous Gapet atayaki

A shrub with crowded, waxy-looking bluish-green leaves. The bark strips off like pago (Hibiscus tiliaceus). The 4-sided yellowish flowers are fleshy. The fruit is red, almost 1 cm long, and poisonous.

Scaevola taccada

Indigenous Nanasu, half-flower

A large shrub with thick, light green leaves and soft wood. This plant is easy to identify by its 'half flower'. It's really all there but looks as though it's been cut in half. The fruits are round and green when young, and white when ripe. They are juicy and the juice can be used as an eyewash.

This bush is a coastal species on many islands. On Guam it is common along beaches but also occurs in the savanna.

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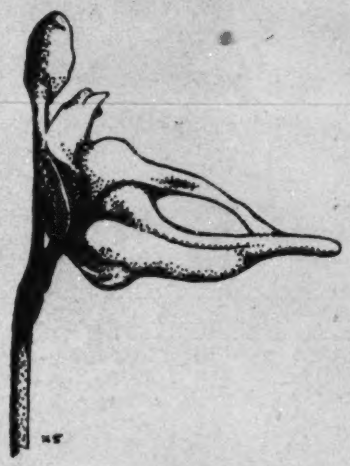
Utricularia

Indigenous Bladderwort



If you visit the savanna during a wet part of the year you may find some striking tiny bright yellow or white flowers on a moist bank or along a gully.

These are one of Guam's hidden beauties, Utricularia. There are 2 species here, one with white flowers and the other with yellow flowers. Both have thin, unbranched stems and tiny leaves. The seeds are inside little oval pouches below the flowers (when there's fruit).

These beautiful little plants are carnivores! They trap tiny animals in their underground or underwater bladders and digest them.

Melastoma marianum

Endemic in Micronesia

Gafo'

Flowers white to light pink. Shrub. The heavy palmate (branching) veins in the leaves are characteristic of the family Melastomataceae.

Exercise I

Savanna Fieldtrip

A. See how many of the plants in this booklet you can find in the savanna. Make a list of them and after each describe the plant, how it grows, and how common it is. (How often do you see it and about how many specimens each time?)

B. Dig two straight-sided holes about 15 cm deep, one in an area of bare savanna soil and the other in an area covered by vegetation. Describe any differences you see in the 'soil profile' (texture and makeup of the soil from the surface down to 15 cm deep). Put the soil back in the holes and tamp it in.

C. Lie on your back and look up at the clouds. Clouds are formed when water vapor condenses. They disappear as condensed mist evaporates again. Perhaps you can see clouds being born or dying in the sky above you. Feel the wind blowing where you are. Look up at the clouds and watch how the moving air up there is shaping them. Do you think the wind up there is the same as it is where you are? Write something in your notebook about the clouds.

D. Lie on your belly and watch any living thing you see on or near the ground. In your notebook describe it and what it does. Look at it through your 'See box' (your teacher will supply one) and list any new things you notice.

E. Make a list of any animals you see and what they are doing.

F. Stretch out your arm and follow the contours of the hills around you. If you were a drop of rain that landed in the highest area around, where would you flow? What would you see as you run down the hill and into a gully and down the gully into a river?

G. Draw at least one plant or animal that you see in the savanna.

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Old Fields and Roadsides

The plants and animals we find in Guam's old fields and along roadsides are a combination of indigenous Guam species and introduced species. Whereas plants of the savanna are adapted to burning, Guam's roadside plants can withstand frequent cutting. They represent an ever-changing array of life forms that can generally be traced back to some fairly recent point in Guam's history. In order to understand how these old fields and roadsides developed, let's take a short look at what plant life on Guam has been like through the years.

Before People Came to Guam

Once upon a time, there were no old fields or roadsides here. The Guam ecosystem was made up only of indigenous Guam plants and animals. These included species that had developed on Guam or in the Marianas and lived only there. These endemic species are especially adapted to conditions in the Marianas. They occur nowhere else in the World. The Appendix has a list of these only-on-the-Marianas plants.

The natural communities on Guam before the coming of man included: the strand community (along the shores), the mangrove community, limestone forest, southern ravine forest, and some savanna. The mangrove community of Guam looks about like other mangroves of the World. The species found in Guam mangroves are also found in the much bigger mangroves of Caroline high islands like Yap, Palau, and Ponape. The strand communities of beach areas are similar all over Micronesia. The same plant species are found on almost all beaches of Micronesia and many other parts of the Pacific.

The mangrove and beach strand are pretty specialized places to live. It takes especially-adapted plants and animals to live in the mud and in sand and salt spray. Foreign plants aren't likely to invade the heart of the mangrove or the edge of the beach. These areas remain about

the same as they always were, although they may be surrounded by old fields and roadsides today.

Guam's limestone forest is special. It too is an only-on-the-Marianas. Most of Guam's endemic species live here. This forest once covered most of the northern half of Guam.

Typhoons, Erosion

Typhoons have been a big factor affecting Guam's forests. At least the coastal forests might be considered as typhoon-adapted. They are low-growing and cling tightly to the rocks.

Southern Guam has quite different soils from northern Guam. The northern limestone soils are very porous. Southern volcanic clay doesn't absorb water so well and where water can't go down into the soil, it runs off. As it runs off, it carries soil. Little by little, rivulets, gullies and ravines are formed. In southern Guam, there are lots of rivers and ravines.

We don't really know what the vegetation of most of Guam's southern hills was like back before man came to Guam. Probably there was a lot more forest then, and a lot less swordgrass. There may have been a lot more ironwood and ferns. There was some open savanna with herbs, bushes and small trees and areas of short grasses. We know these must have been around for a long time because of the endemic species that developed there.

Today we can look at the protected Naval Magazine/Fena Lake area——and wonder if this is what the rest of Guam's hills might have looked like at one time.

Early Man on Guam

Early man brought many plants and animals to Guam. These include many things that people eat, like coconuts, bananas, taro and pigs. Rats also came along for the ride. The Appendix gives a list of the plants probably brought to Guam by early man (Pre-European).

Man brought fire. Fire was a main tool of the farmer. He had no iron cutting-tools in those days to use in clearing vegetation for planting. An area was burnt to clear it, planted for a time and then left fallow (unused) to go wild again. When land lies fallow and several generations of plants live and die there, it acquires a layer of dead leaf and develops nutrients and a nice crumbly structure for growing plants. Then it may be cleared again and used to grow more crops for awhile. Things seem to work out O.K. until an area is burnt too often.

Burning removes plant cover and humus. It leaves the soil exposed to the sun and rain. Rain washes away nutrients and sun bakes clay soils hard. (In some parts of the World such baked clay is used for building bricks.) When an area is burnt too often, too much humus is removed and the soil is exposed to the sun and rain too much. It becomes degraded and won't support plant life well. Many of Guam's southern soils are being degraded. This process may have started long ago when fires began to be frequent on Guam.

Guam's Mexican Plants

For nearly 250 years, Spanish galleons stopped at Guam on their way from Acapulco, Mexico, to Manila in the Philippines, and back. They brought many plants including the kamachile tree (to use in tanning hides), the achoti tree (used to color red rice), the pretty kadena de amor (that pink or white flowered vine) and sweet potatoes, corn, chili peppers and cassava (tapioca, mendioka). These plants became Guam residents and contributed to Guam's way of life yesterday and today.

Exercise II

Which Plants Do You Know?

Go through the list of endemics, introductions by early Guam man, and Spanish introductions in the Appendix. How many endemics do you know? How many introductions of early Guam man?

How many Spanish introductions? Tally up the class total. What do they tell you about young peoples' plant knowledge on Guam? Put your results and the class results in your notebook and write a discussion of their meaning.

The Impact of the Second World War

During this war, much of Guam was bombed, burnt and bulldozed. That did a lot of damage to Guam's natural communities. After the American re-takeover of Guam, there was a great deal of bulldozing and packing of areas with coral fill in order to build military installations. There was also a lot of road-building. That was when a lot of Guam's old fields and roadsides were created. These cleared areas in general became inhabited by newcomer plants. One of these was tangantangan. After the war, the Department of Agriculture under the naval government had the island seeded with tangantangan to prevent erosion, successfully as it turned out. The results can still be seen today.

More Changes

Even though people are more or less at peace now, Mother Guam continues to get clobbered by typhoons, scorched by fires, scraped by bull-dozers, and overrun by invaders. It sometimes seems that people are trying to destroy true Guam. They even manage to destroy places they can't get to. If you look below the Hawaiian Rock quarry, the University of Guam dorms, or the NCS radar domes, you'll see that bulldozers have cleared areas at the top of the cliff and dumped the debris all down on top of the forest below. If you go to the end of Tarague beach, you'll find a place where old bombs were detonated in the sand where they wouldn't do much damage. Further down the beach you'll also see a pile of rubble that was once a lovely forest-covered overhanging rock. Somebody decided to set a bomb off there. Why?

Guam's pretty shaken up. Guam's populations of plants and animals keep changing and moving around. Let's look at some of these happenings.

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Closeups of Some Changes

At various times in the 1950's large swarms of yellowjacket wasps occurred. The 1960's and early 1970's saw great swarms of termites. Between the mid-1950's and mid-1960's the common little blue-tailed skink was replaced about houses by the green anole lizard. Was the little blue-tail skink afraid of the newcomer, or did it miss the boondocks that were being cleared from around houses? The 'boondock houses' of early days were full of the friendly little 'island canary' gecko, Lepidodactylus lugubris. You can identify this gecko by the column of W's on its back, or if these are too light to be seen, there will be two dark spots in front of the tail. The chirps of this gecko are common, especially in the mornings and evenings. In the quiet of middle night, there were murmurings of the big fat gecko, Gehyra oceanica.

Today's houses are more streamlined, bright and noisy. The little island canary gecko is being replaced by the larger aggressive gecko, Hemidactylus frenatus, which is not as likely to come to the breakfast table to lick at drops of syrup. The shy Gehyra oceanica is now seldom seen or heard except by quiet people in quiet places.

Housemice used to be seen a lot. Then shrews came to Guam. As shrews increased in number fewer housemice were seen. They probably became more secretive in their habits in the presence of the bold shrew. The shrew in turn had its heyday and is now less often seen.

Barrigada Hill road once wound through limestone forest. There were yogga' (Elaeocarpus sphaericus) and ifil (Intsia bijuga, Guam territorial tree), and dokdok (Artocarpus mariannensis, Marianas breadfruit) on both sides of the road. The sihik (Micronesian kingfisher) and sali (Micronesian starling) flew above, and the ko'ko' (Guam rail) ran across the road. The forest was fragrant in the cool moist morning air.

Even in the mid-1960's, the driver could thrill to the yogga's beautiful 'bonsai' formation all decorated with red leaves, blue fruit, and in season, delicate white blossoms. In years past, one could even see fruit bats coming to feast on these blossoms. The air along the road would occasionally be filled with the very sweet scent of the male Pandanus blossoms.

As years passed, bulldozers provided areas for tangantangan in place of forest, and for about half a dozen years, parts of the roadside were lined with the 'weeping' branches of the graceful Buddleja asiatica and then the Panama cherry, mansanita (Muntingia calabura), that looks like a short squat version of the elegant yogga' (the two are in the same plant family). Later years saw lots of sayafe (Melochia), which for awhile lined the road with pink blossoms. This tree gave students of plants a great look at hybridization (cross-breeding) of two species into an interesting intermediate. Then tangantangan moved in and tried to take over the area. The bulldozer ended the spectacle and competition. It made the road wider and flattened the forest on the sides. Now it is possible to travel with such speed that one may not notice the life along the way at all. Two yogga' trees are left which will die in the years to come. The bulldozer also removed both the forest and soil from Barrigada Hill. Now there are crowded rows of houses instead.

Harmon airfield has seen several waves of dominant plants. After the airstrip was abandoned, tangantangan and a bush called Pluchea odorata grew up in the areas between the paved strips. P. odorata is a big bush with thick leaves. It used to be very common around the Harmon airstrip. Nowadays you'll have to search to find even one. Some time later the area was invaded by Pennisetum setosum, that yellow-tailed grass. Next came wild cane (Saccharum spontaneum). If you drove down Barrigada Hill road and looked out over Harmon airstrip the summer of 1971, you could have seen a beautiful mosaic of gold and silver patches. Those were the golden flowers of the yellow-tailed grass, Pennisetum setosum, and the silvery heads of wild cane. The sight was beautiful for

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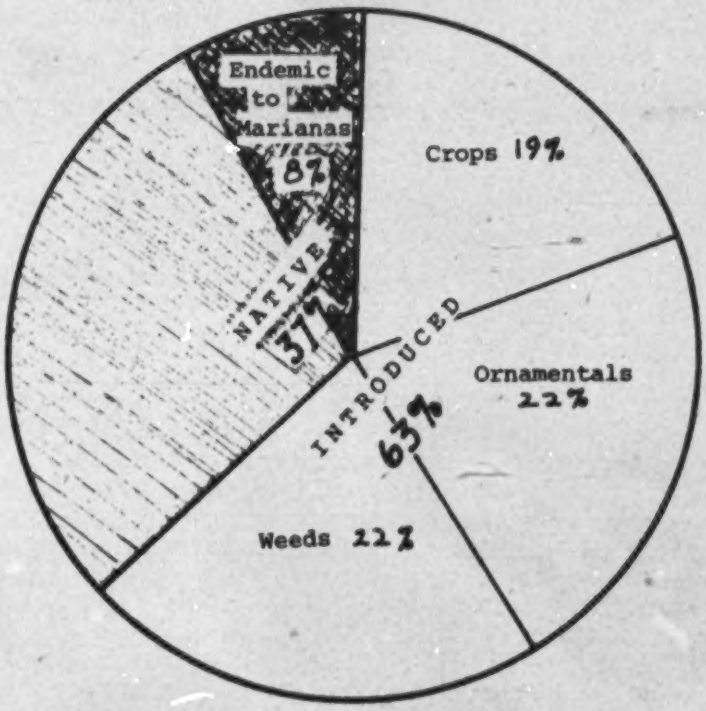
the human eye. For P. setosum, it may have been the main battle of a war it lost. Today (summer of 1975) the area is dominated by the silvery-topped wild cane. There are big patches of another, larger, species of Pennisetum, P. purpureum, and the smaller P. setosum is mostly gone.

Some years ago, there was a patch of 'padang padang grass' at the northern end of Harmon field. This grass is a troublesome weed in some parts of the Pacific and a lot of money is spent fighting it. The patch at Harmon flowered and thrived for awhile and then was bulldozed away. Today we don't know if the padang padang grass is gone or just biding its time, waiting until it too can be 'king of Harmon field' for awhile.

Guam Plants Today

About 63% of the species of plants that live on Guam are not from Guam. This percentage will probably continue to grow in the future. Here's a 'plant pie', showing the makeup of Guam's plants:

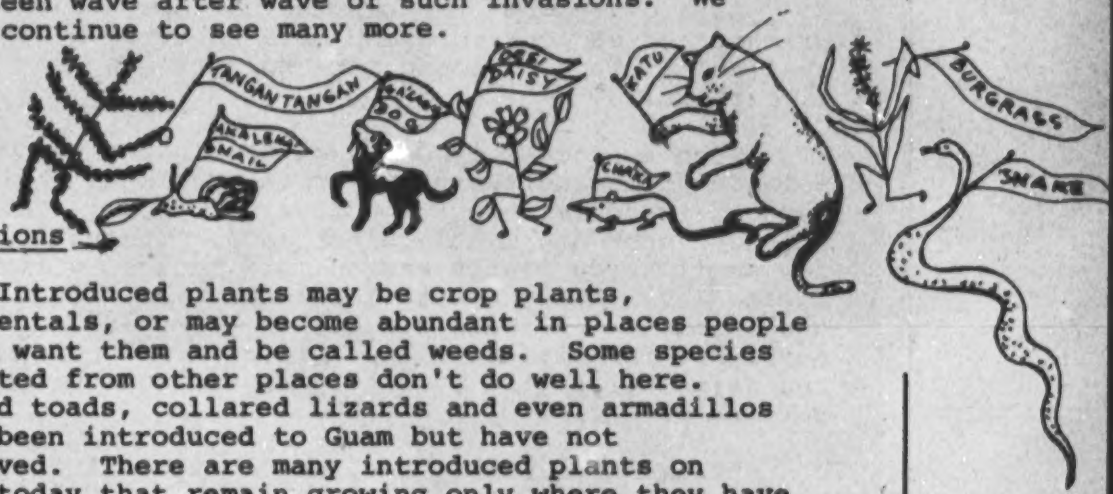


Exercise III

In your notebook draw or trace this plant pie. Then draw radiating lines around it. Write in names of plants that you know in each category. You may want to use The Flora of Guam.

Some Ecological Factors of Change

Guam's old fields and roadsides of today have become a hodgepodge of plants and animals from Guam and from all over. Disrupting the natural plant cover of an area is something like scraping off the skin of your own arm. It is often followed by an infection. When Guam's soils are left exposed, they are easily invaded by the most aggressive species around. Because of Guam's location as a 'crossroads of the Pacific', and its good climate, many foreign species are able to invade the scratched skin of our Island. Guam has seen wave after wave of such invasions. We will continue to see many more.



Invasions

Introduced plants may be crop plants, ornamentals, or may become abundant in places people don't want them and be called weeds. Some species imported from other places don't do well here. Horned toads, collared lizards and even armadillos have been introduced to Guam but have not survived. There are many introduced plants on Guam today that remain growing only where they have the care of the one person who wants them. Without that care, they would die. Newcomers react differently when they get to a new place.

Other species leap onto Guam and love it. They seem to want to take it over. One example is the little Eurasian tree sparrow which spread over Guam in a surprisingly short time. Drongos, anoles and rat snakes are other animal examples. Tangan-tangan, Pennisetum, Bidens (Guam daisy), and Lantana are plant examples.

Why do they thrive as they do? Perhaps it's because the enemies that they had back where they came from aren't on Guam. Perhaps Guam's climate really suits them. Perhaps there's lots of the kind of habitat that they like here on Guam and little competition for it.

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Many invaders expand wildly at first, then gradually settle down as permanent residents of Guam. The anole, the green lizard that can change to brown, did this. When it was new on Guam it spread rapidly and grew to a larger average size than it did back home in North Carolina.

Succession

Primary succession happens when a naturally bare area becomes inhabited by 'pioneer' plants and animals. This happened on Guam a long time ago.

As a place goes through the various steps of primary succession, more and more habitats become available. Then more and more species can live there.

Such a process is going on now in the young islands at the northern tip of the Marianas chain. Some of these islands are active volcanoes. The youngest ones are mostly black lava. Gradually a few small hardy plants and animals manage to live in the lava. They are succeeded by other plants and animals. As these die off they provide nutrients for different and more numerous plants and animals. Little by little the islands become covered with life.

Here on old Guam, 'secondary' succession is common. This happens after a natural plant and animal community is damaged or removed, generally by bulldozing. The plants that now start growing on the bare area are not the original pioneers. Secondary species come along. These are succeeded by other species which in turn are also replaced. Theoretically, and after a long, long time, a forest should return. When the kinds of species in the forest stop changing, it then has reached its climax.

(Optional Activity: Film——A Strand Breaks)

In the United States, secondary succession has been carefully studied. Scientists know which species will grow first, and what species will follow. They even know about how long the different stages of succession take.

Here on Guam, secondary succession hasn't yet been studied. No Guam scientist has watched the changes that occur after a forest is bulldozed down. Although I have lived on Guam for 26 years, I know of no forest here that has been destroyed and has come back again. One reason for this is that generally areas are not left alone long enough for more than just beginning succession to happen. Bulldozed areas are invaded by weeds, are bulldozed again, or have houses built on them. Natural succession doesn't have a chance to complete itself.

In general, the first plants to grow in cleared areas are herbs (small soft plants) and grasses. Sometimes it's a field of wild papayas. These may be followed by shrubs; or tall grasses may move in. Shrubs may be followed by small trees, then bigger trees. Common secondary growth trees are pago (Hibiscus tiliaceus), ladda (Morinda citrifolia), sayafe (Melochia), tangantangan and bamboo.

On Guam the species of herbs change from time to time. Even the species of small shrubs that commonly grow in disturbed areas change. There are a number of shrubs that were once very common in old fields and roadsides that are now rare. Perhaps some of your parents may recall that about 10 years ago, the giant wild taro plant, papao-apaka or papao-atolong (Alocasia macrorrhiza) was very common along Guam's roads. Nowadays it's becoming rare. Why? Has it been crowded out by some stronger species? Is there less water in Guam's soils because we're drawing so much out of our water system? Has so much forest been removed that Guam's roads and old fields are now too hot? Why, why? There's a reason, and perhaps a message there about what's happening on Guam. Someday, Guam's old fields and roadsides may be covered with plants that don't even have Guamanian names.

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Some Common Old Field and Roadside Plants

Leucaena leucocephala

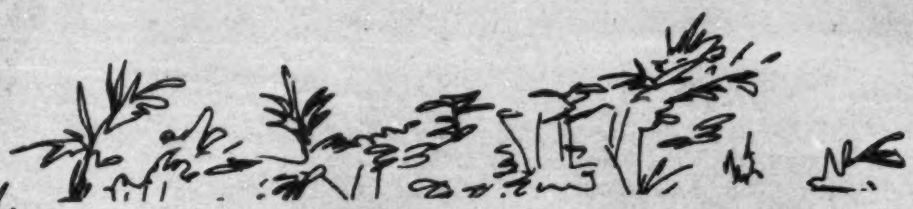
Introduced Tangantangan

This plant has the scientific name Leucaena leucocephala, the Leucaena with the white head. It's named that for its white puffball. Tangantangan is one of the most common plants on Guam. Originally from tropical America, it has been introduced in many Pacific Islands and is now all over. Here on Guam it was seeded by airplanes over the Island in 1944-50. This was done to provide a soil cover and prevent erosion. That's one reason it's all over the place. Another is because it produces a lot of seeds that sprout and grow easily and rapidly. Even a stick of tangantangan will grow if you put it in the ground.

Tangantangan has few enemies. There's a beetle whose larva eats the seeds, but the plant produces so many seeds that it overcomes the numbers lost to the beetle. If goats are penned around tangantangan they will strip and eat the bark off the tree so that it dies.

Tangantangan likes coral soils. It is most abundant in northern Guam. It doesn't do well in the southern volcanic clay soils; however, it follows the coral-paved roadsides that go down south. That's not so bad. Tangantangan doesn't burn as easily as swordgrass and it makes a firebreak along roads where people throw lighted cigarettes.

Probably the biggest use of tangantangan is as firewood. Very often Government of Guam workers cut it down along the roads and then return to pick up the piles of logs for their home fires. Tangantangan is a nutritious animal feed but it does funny things to some animals because of a chemical it contains. If a horse eats a lot of tangantangan, the hairs of its mane and tail fall off! If dried, tangantangan makes a good chicken feed. It gives cow milk a funny taste but otherwise it is a good cattle feed. In Hawaii it's kept cut short and used as livestock feed. In New Guinea it's grown tall and slim in

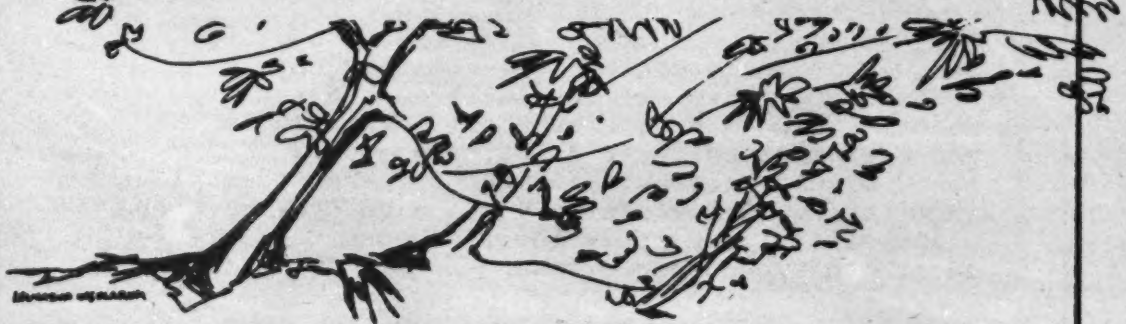


rows between coffee plants to shade them. The seeds are abundant. In the hard days of the war, some people on Guam boiled the seeds to make an imitation coffee. Today many people boil the seeds to soften them and string them as beads.

Snails seem to go with tangantangan. They eat it some but not enough to kill the plant. If you want to find some really big snails and lots of empty shells, find an old tangantangan thicket. The ground is usually just covered with old shells.

This tree is an invader species. When tangantangan takes over a piece of land even man has a hard time taking it back again. The plant doesn't seem to participate in the process of succession.

You may have been surprised that tangantangan is not originally a Guam plant. There is a native kind of tangantangan, though. Its scientific name is Leucaena insularum var. guamense. This species is a nicely-shaped small bush to small tree. Its leaves and seed pods are shorter than on L. leucocephala. L. insularum can be found in some beach areas including those on Cocos Island, near Talofofo, and between Togcha beach and Ypan.



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Exercise IV

Tangantangan--Guam vs Tropical America

Prepare 2 seed beds——these can be boxes or cans of soil about 7 cm deep. Punch holes near the bottom of the box or can so water can drain. Ask your teacher where to get some seeds of L. insularum. You can bring in some from L. leucocephala. Can you tell the difference in the seeds? Describe this in your notebook.

Plant the seeds in separate, labeled containers. Keep records on the growth of the seeds. Which ones sprout first? Can you tell the 2 species apart when they are young? Raise the 2 plants to about 15 cm high. Then transplant them outside. Be sure to put a sign by your young plant saying that it is the real Guam tangantangan, so it won't be chopped down.

Foreground, yellow-tail grass invading a field of swordgrass. Tree is kaffo'.

Pennisetum purpureum & P. setosum

Introduced

P. purpureum is called elephant grass and napier grass. It comes from tropical Africa. It's very abundant and very tall, taller than a person. Sometimes it branches. It can be used for cattle feed.

P. setosum is smaller, probably about as tall as you; it too has a yellow inflorescence. It doesn't branch. There seems to be no established common name for this species. We might call it yellow-tailed grass. P. setosum is from Florida, W. Indies, Mexico, Brazil and Bolivia. It came to Guam a long time ago and has spread all over limestone Guam. It loves coral soils even when they are thin and it will grow on almost bare coral. It has a long fibrous root system that forms mats over areas with thin soil. P. setosum is not confined to limestone soils. It shows its adaptability and has jumped into the volcanic clay savannas of Guam. It even competes with swordgrass. P. setosum's special weapon for survival is the fast way it produces many seeds. Sometimes you'll find a P. setosum with seeds that have sprouted and started to grow while still on the plant! This species can be fed to cattle when it's young but it seems too tough when it's old.

Imagine these two 'cousins' (different species of the genus Pennisetum). They originally came from different parts of the World ——one from tropical Africa, and the other from tropical America. Now they find themselves growing together on Guam!

Exercise V

How Many Seeds?

Get a ripe inflorescence of P. setosum. Break it apart and divide it among all the members of the class. Count the numbers of seeds in the inflorescence. Does this tell you anything about how P. setosum can compete with other plants?

Exercise VI

Just for Fun--A Pennisetum Caterpillar

Make a crawling caterpillar. Hold a ripe inflorescence of P. setosum lightly in your left fist with the stem between your thumb and first finger. Pull the stem out with your right hand. Now open your left hand and let your caterpillar crawl away!

Go for a morning walk in an old field with P. setosum around. Give yourself an early morning dewbath. Gently pull out a dew-covered inflorescence and slap it against your face. You'll be sprinkled with dew and instantly awake and refreshed. Come on, try it, you'll like it!

Stachytarpheta indica & S. urticifolia

Introduced Laso' katu, false verbena

S. indica is a common secondary shrub, especially in volcanic soils. It has pale green flat leaves and pale blue flowers on long spikes. There's also an S. urticifolia that is much less common on Guam. It's bigger than S. indica and has dark green crinkled leaves and a deep dark blue flower. An interesting thing about these two species is that both occur on Guam and also in our Western Caroline Island neighbors. On Guam, S. indica is common and S. urticifolia rare. In other areas, S. urticifolia is the more common of the two. If you find a patch of S. urticifolia and S. indica growing next to each other, look for hybrids. Hybrids are plants whose parents were different varieties or species.

The characteristics of hybrids are usually between those of the parent plants. The hybrid of S. urticifolia and S. indica has leaves that are only a little crinkled and medium blue flowers. It grows bigger than either of its parents, though.

Exercise VII

A Sip of Nectar

When you go for your morning walk, follow your yellow-tailed grass dewsplash with a sip of sweet nectar. Pull a blue false verbena flower gently from its spike. Suck the bottom of the tubular flower. You'll taste the sweet flower nectar that bees use in making honey.

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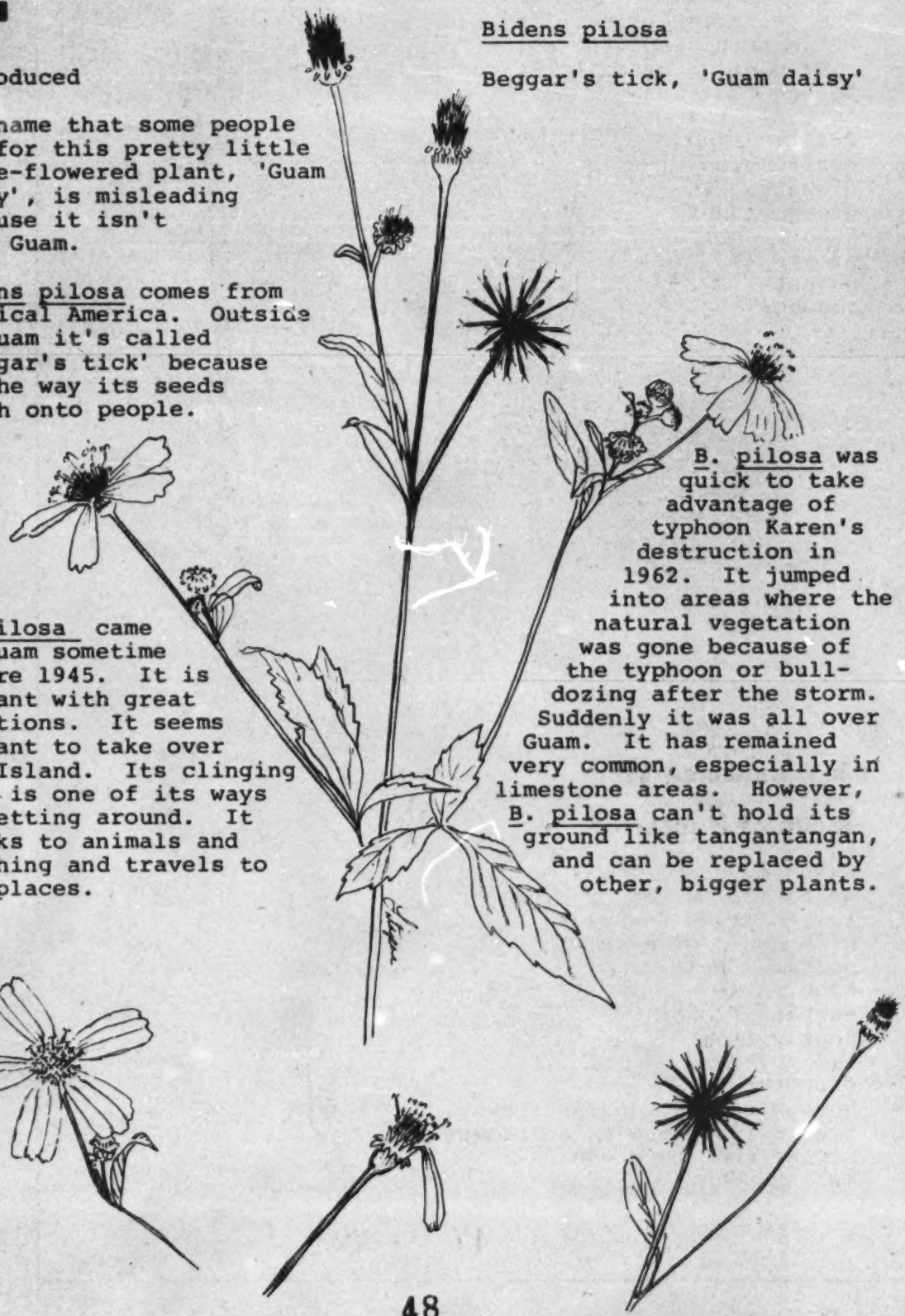
Introduced

Bidens pilosa

Beggar's tick, 'Guam daisy'

The name that some people use for this pretty little white-flowered plant, 'Guam daisy', is misleading because it isn't from Guam.

Bidens pilosa comes from tropical America. Outside of Guam it's called 'beggar's tick' because of the way its seeds catch onto people.



B. pilosa came to Guam sometime before 1945. It is a plant with great ambitions. It seems to want to take over the Island. Its clinging seed is one of its ways of getting around. It sticks to animals and clothing and travels to new places.

B. pilosa was quick to take advantage of typhoon Karen's destruction in 1962. It jumped into areas where the natural vegetation was gone because of the typhoon or bull-dozing after the storm. Suddenly it was all over Guam. It has remained very common, especially in limestone areas. However, B. pilosa can't hold its ground like tangantangan, and can be replaced by other, bigger plants.

B. pilosa is a weed of many parts of the World. Perhaps some of you from other parts of the Pacific, Asia, or Florida knew it back there.

Like many other wild plants, B. pilosa can be eaten. The tender tips can be boiled as a vegetable. Unfortunately they taste a little like turpentine, so you need a lot of butter or other flavoring. Unlike other cooked vegetables that go limp, B. pilosa holds its shape and crispness even after it is boiled.

Exercise VIII

Preparing Plant Specimens

You may want to press and mount some of Guam's old field and roadside plants so that you can put them up on the wall while you study this unit. To do this, get the following equipment: a plant press, corrugated cardboards, some old newspapers, herbarium mounting paper, and glue. If you don't have these at your school, you can make them with 2 pieces of plywood or other wood frame about 30 cm x 45 cm with corrugated cardboards of the same size. Make sure that the pipes through the cardboard run perpendicular to the length of the press. This allows good air flow. Collect your plants, making sure to get enough of each plant to show what it looks like. Place it inside the folded sheet of newspaper. Arrange it in a natural shape, if possible. (If it's too long just bend the stem as necessary.) Place it between cardboards. Put these between the wood frame boards. Press the boards together by tying two straps or ropes very tightly around them. Dry the plants in a plant dryer. (You can use an oven with just the light turned on——no other heat.) If your school doesn't have a plant dryer or oven you can use other methods. Put the press over several lightbulbs, or perpendicular to a fan.

When you can't dent the thickest part of a plant with your fingernail, it is dry enough. Check the plants every 2-3 days. When they're dry take them out and glue them on sheets of herbarium mounting paper or other heavy paper or cardboard. Make a label for each sheet. On the label give the plant's name if you know it. Also tell where it's from, what it's like, and the date you collected it. Include other interesting information about the plant.

Exercise IX

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Savanna vs Old Fields and Roadsides

Let's compare the savanna community with old field and roadside plants. Here are two lists of common plants of these locations. After each species is an E for endemic (to Guam or Marianas) or I for indigenous; or if the plant is introduced, its original home is given. What can you say about these lists?

Savanna

1) Miscanthus floridulus (I) nette, swordgrass
2) Dimeria chloridiformis (E)
3) Dicranopteris linearis (I) mana, staghorn fern
4) Myrtella bennigseniana (E)
5) Melastoma marianum (E) gafo'
6) Geniostoma rupestre (I) maholok hayu, nanasu
7) G. elliptica (I)
8) Decaspermum fruticosum (I)
9) Timonius nitidus (E) maholok layu, sumak ladda
10) Phyllanthus saffordii (E)
11) Casuarina equisetifolia (I) gagu, ironwood, Australian pine
12) Chrysopogon aciculatus (I) inifok
13) Hedyotis megalantha (E) paode'do'
14) Pandanus fragrans (E) kaffo', screw pine
15) Cheilanthes tenuifolia (I)
16) Blechnum orientale (I)
17) Lycopodium cernuum (I) patas nganga', wolf foot, out-of-focus plant
18) Scaevola taccada (I) nanasu, half-flower

Old Fields and Roadsides

1) Chrysopogon aciculatus (I) inifok
2) Nephrolepis hirsutula (I) amaru
3) Hibiscus tiliaceus (I) pago
4) Morinda citrifolia (I) ladda
5) Passiflora foetida - Probably America; mediu dia, passionflower
6) Leucaena leucocephala - Tropical America; tangantangan
7) Pennisetum setosum - Florida, W. Indies, Mexico, Brazil, Bolivia yellow-tail grass
8) P. Purpureum - Tropical Africa
9) Bidens pilosa - Tropical America beggar's tick, Guam daisy
10) Saccharum spontaneum - Paleotropical (widespread in tropics for a long time); wild sugarcane
11) Chloris barbata - Central and South America or E. Indies; fingergrass
12) Antigonon leptopus - Mexico kadena de amor, chain of love
13) Mikania scandens - Tropical America
14) Conyza canadensis - North America
15) Carica papaya - Tropical America papaya
16) Cenchrus echinatus - New World español, laso' katu, burgrass
17) Stachytarpheta indica - Tropical America; laso' katu, false verbena
18) Elephantopus mollis - Trop. America papago' baka, papago' halom tano'

Exercise X

Physical Factors and Habitat

A. Mapping Environmental Factors

On Guam a lot of plants and animals compete for limited space. Some plants have certain requirements for growth. Others can live under many different conditions though they do best under certain optimal (most favorable) ones. Environment has a lot to do with which plants grow where. Some main environmental factors are sunlight, moisture and wind intensity. Let's consider different combinations of these around a big packing crate (see p. 65) or around the school.

Make a map of your packing crate area or your schoolyard. Indicate the direction the sun passes and the direction from which the wind generally blows. This is also the direction where the rain normally comes from. Show which sides of the box or school building are moist and which are dry. Indicate any differences in types of soil. (For your experiments, you will want to use plots that have the same kind of soil.)

Measure the physical factors at 2 different sides of your box or school. Do this using a maximum-minimum thermometer, wet bulb-dry bulb thermometer (which measures the moisture content of air) and wind vane if you can. If no wind vane, use a magnetic compass and a dropped blade of grass or wet finger to determine wind direction. Add your measurements of physical factors to your map. If there are other classes studying this unit, ask them for the measurements of physical factors during their classtime. Add these to your map.

B. Plants in Different Places

Mark off a quadrat (study square or circle) on the ground on 2 sides of your box or school building. This study area should be big enough to include a good sample of the wild species growing there and small enough so that it is possible for you to make a list of all of them.

Put a fence around the quadrat. Leave it to grow without disturbance.

When the plants in your study plot are big enough to identify, make a list of them. If you know their names, fine. If not, call them by letters, Plant A, Plant B, etc. and keep a drawing or specimen of each one (see Exercise VIII). Make lists of the plants in all study areas. Compare these lists. Are there any plants that grow in more than one place? If so, do they grow better some places than others? Discuss possible reasons.

After each plant on your list, indicate the kind of habitat it prefers by writing down the location in which it is found.

Pick two of the most common plants that grow in only one of the quadrats and look for them around your neighborhood. See if you can find them growing under any different conditions from at school. If so, describe how they looked. Do you think they were found in only one place because they just hadn't happened to get to the other areas, or was it because they couldn't live under the environmental conditions in the other habitats?

C. Animals in Different Places

Search for animals in your study ground. Collect as many as you can. You can use your hands, nets, nooses, aspirin bottles or any other equipment you can invent. Count or estimate the number of each kind of animal in the area. Examine them closely with a magnifying glass or a See box (a plastic box with a built-in lens). How do they move? How do they eat? How are they adapted (fit) for living in their habitat? Make a list of all of the animals. If you know their names, fine, if not, call them by Roman numerals, Animal I, Animal II, etc. and keep a sketch of each one.

Compare the animals found in different study plots. Which plot has the most animals? Why do you think more animals can be found there? Are there any animals that are found in one area and not in another? Pick two and see if you can find them in other parts of your school or around your home. If you find them in other places, compare those areas with your study areas. Are the conditions about the same or different? Write a short paragraph about each animal. Tell what kind of environment it seems to like.

D. Scattered Seeds

Clear plots of soil on 2 sides of your box or school. Record the environmental conditions in each. (See part A of this Exercise.)

Collect seeds from different wild plants, especially from weeds. Throw half of them into a bag and mix them up well. Divide each set into 2 groups. Sprinkle these seeds evenly over half of your plots of soil and cover them lightly with a little sprinkled soil. From the other half, plant each kind of seed in a row and mark each row with the name or letter of the plant. Sprinkle a little water on the area. Now watch the areas and keep track of what sprouts and grows. You will be able to identify the seedlings by looking at the ones in the rows you have marked. Pull out any seedlings that you don't recognize. They probably came from seeds of plants that were there before you cleared the place.

Compare the growth of all the species in your plots. Which ones sprout first? Which ones grow most vigorously? Which ones seem to prefer certain habitats over others? Do some species grow better in one study area than another? If so, why do you think it happens?

E. Potted Plants

Pick plots on 2 sides of your school or box and describe them as part A of this Exercise.

Grow potted plants in or around your classroom. Include some hardy species and some tender species. Plant them in cans or boxes. Grow at least 4 times as many plants as you have pots.

Place 2 of each species of potted plants in your plots. Leave them there without any care. Keep notes on what happens to them in each locality. Which species have the widest tolerance? Which species prefer certain habitats?

Some Animals of Savanna, Old Fields and Roadsides

Bufo marinus

Introduced Marine Toad

This toad is a World traveler and resident of many lands. It was introduced to Guam about 1937, to eat land slugs and insects. By 1949 it was common in many areas.

Bufo marinus is a successful invader, producing lots of young. This toad breeds whenever it's been raining for a long time and there are big puddles. You've probably seen its long string of gelatinous egg cases. Many tiny tadpoles drop from these strands. They remain quiet on the bottom for awhile, breathing through gills. They grow by eating algae and organic debris. If you turn them over you can see their long intestines. There are gill slits on each side of the head. They swim about with the help of the long tail. At some point they metamorphose (change in form) into tiny little toads. First little hind limbs bud out. Then as the hind limbs grow, tiny front limb buds appear. All this time the tail is getting smaller. They spend more time near the edge of the puddle until one day they just hop away.

One thing that makes B. marinus successful is the short time its eggs take to develop into tadpoles and tadpoles into little tiny toads. This is an advantage in an environment where there are temporary rain puddles. It means that before the puddle dries up B. marinus can produce hopping young that can survive on land. There's even a relationship between the depth of the puddle and how fast tadpoles metamorphose. You'll find out about this in the experiment on shallow- and deep-water tadpoles.

B. marinus doesn't seem to be as common in many parts of Guam as it used to be. One reason for this may be that there aren't as many puddles as there used to be. Back when Guam had lots of dirt roads, there were lots of puddles. Nowadays there are more paved areas and fewer puddles.

B. marinus can be found in savanna areas. Savannas are often hot and dry. They also get burnt over often. B. marinus manages to survive there by burrowing. When it's hot the toads stay in tunnels under the ground. It's cooler there and moister. If a fire comes along, toads are generally safe down there in their tunnels.

Be a little careful when you handle B marinus. They have large parotoid glands. These are bumps just back of the head. These glands produce a white sticky poisonous substance. If you get some of the sticky stuff in your eyes, it really hurts. Dogs that eat toads sometimes get puffed up mouths and may get sick from this poison.

When it rains hard, B. marinus come out to mate in puddles. Near the end of a typhoon one of the most calming sounds is the trilling of these toads. They will gather by hundreds sometimes and produce a beautiful chorus of high and low trills. They seem to say "All's well again, you can sleep".

Exercise XI

The Bufo Chorus

Record the sound of a Bufo chorus. Bring the recording in and play it for the class. Play it in the evenings and see if it calms you and makes you sleepy.

Exercise XII

Littoral and Pelagic Tadpoles

'Littoral' and 'pelagic' are words that are usually used in talking about the ocean. Littoral means along the shore, therefore shallow, and pelagic means in the deep ocean. We will put our tadpoles in freshwater littoral- and pelagic-type habitats.

For this experiment you'll need 2 identical aquaria. Put about 3-4 cm of rain water and a slanting board or flat slanting rock in one

aquarium. Fill the other with rain water until it's about 25 cm deep. Don't put any rocks or floating objects in this aquarium. Bring in about 20 small tadpoles. Make sure that they don't have leg buds yet. (You could also use a string of eggs.) Put half in one aquarium and half in the other. If there are no green algae in the aquaria, feed the tads a little bread or algae or other scraps. Don't give them too much; you don't want to foul the aquaria.

Keep notes on any changes that occur to the tadpoles in the two groups. Summarize your observations after the first tadpoles have metamorphosed into little toads. Discuss the results of the experiment.

Exercise XIII

Warm and Cool Hoppers

Toads are amphibians. Amphibians, reptiles and fish do not maintain a constant body temperature. Their temperatures vary with the temperature of their environment. If it's warm they tend to be warm, and if it's cold, they're cold. An organism's body temperature has a lot to do with its metabolic rate (the rate of its body processes), and how active it is. You can find out something about body temperature, metabolic rate, and activity in the following experiment.

Bring in 6-8 toads. Divide them into two comparable groups. Mark one group with dabs of white shoe polish. Put each group in a box or can or sack with breathing holes. Place one group in an ice box (not freezer). Put the other group in a corner of the room where it's warm but not too hot.

Clear a big area of floor in the classroom, or go outside. After the toads have been in the ice box 1 to 2 hours, take both groups out. Let them out onto the floor or ground. Watch each toad and count the number of times it hops for about 15 minutes. You may want to draw a circle and have a toad race. Put them in the center of the circle and see which group hops out first. Do count the number of hops, though. Which group is more active?

Record your results and discuss them. From this experiment what can you conclude about the effect of temperature on activity?

Exercise XIV

Residents or Passersby?

Perhaps there's a light outside your house. This light attracts insects. Bufo marinus eat insects. Watch them. How do they catch insects? Mark all the toads you find. You can use a small spot of spray paint or fingernail polish or white shoe polish. If there aren't too many, 'name' them by putting different numbers of small spots on their backs. If there are lots, use a limb-spotting method. Put one spot on one limb, or two spots on two different combinations of limbs, or spots on three limbs. With this marking code, you can identify a lot of toads individually.

Watch the area the next night. Count the number of marked toads that return. Count the number of unmarked toads that appear. Do this for 3 nights. Do the same toads keep coming back, or does the little population that eats under your outside light keep changing?

You might do a similar investigation with African snails. To attract them just throw out some vegetable matter like breadfruit or banana peelings.

Varanus indicus

Hilitai, monitor lizard, 'iguana'

The monitor lizard, hilitai, is a beautiful large black lizard with yellow spots. The combination of yellow spots on a black background makes it look green. It may grow to about 1.3 m long. It's the biggest lizard on Guam and the only one with a deeply forked tongue. Many people call it an 'iguana'. This is not a correct name. Iguanas are plant-eating lizards from the New World. Monitors are meat-eaters from the Old World.

The hilitai is sometimes seen in old fields and especially along roadsides in wooded

areas. It comes to the roadsides to bask in the sun in the morning and evening. It also comes to eat things like crushed snails and birds that have been killed by passing cars. It too is often hit and killed along roads.

The monitor can run, swim and climb trees. Its side-to-side motion as it runs blurs the spots and makes it blend in with green vegetation. It may seem to disappear right before your eyes. Monitors like to lie in water. They can swim if you throw them in deep water but don't seem to go into the sea on their own. They have sharp claws that help them climb. When they climb to get away from you, they are clever and keep on the opposite side of the tree from you so you can't see them.

Monitors have a bad reputation for eating chickens. Some hilitai do eat some chickens. They also eat a lot of rodents, insects and dead and sickly animals. In doing so they help keep living populations healthy by removing dead and sick animals, those which could spread diseases.

The hilitai lays soft-shelled eggs like other snakes and lizards (except geckoes). If you find a nest, don't disturb it. If you dig it up and try to keep it at home or school, the eggs will probably dry up and the embryos will die. Leave the nest where it is. If you want to see the young when they emerge, place a wire box on top of the nest.

Baby hilitai are beautiful. Their spots are clustered in little rosettes. As they grow older, these spots spread out. Adult hilitai have evenly-scattered spots.

The hilitai are among the most intelligent of lizards. They make good pets if you start with young ones. They live a long time. It's best to keep them in a glass or fine-screen cage. If the screen is big-holed, they may rub the skin off their noses by poking them through the holes trying to get out. Give them a large container of water as they like to lie in water. Feed them eggs, hamburger, crushed snails, small rats, etc. If handled from the time they are small, they'll learn not to bite you. Large lizards bite and

scratch. If you do get bitten, don't pull your finger out against the backward-pointing teeth. This will make them go deeper. Instead, pry the lizard's mouth open with a twig and then take your finger out.

This animal is like a living fossil. Fossils of giant monitor lizards that lived about 50,000 years ago aren't much different from the monitors of today. One living close relative of the hilitai is Indonesia's Komodo Dragon, Varanus komodoensis, which may reach a length over 3 m and weight of over 600 kg! There are about 30 living species of monitors, including about a dozen that live in Australia. The species that lives on Guam, V. indicus, is widespread in the Old World.

Monitor lizards have some characteristics of snakes. They have long, deeply-forked tongues, as some snakes do, associated with a sensory organ that helps them smell/taste their way to food. They have long necks and a habit of swallowing their food whole, also like snakes. If you look closely at the top of a monitor's head, you'll see a depressed scale. There's a hole in the skull under that scale where the pineal body comes near the surface. The pineal body in humans is an interesting structure which seems to influence the work of other glands in the body. In ancient reptiles it seems to have been sensitive to light. Perhaps it is the remains of a third eye. There is a living reptile in the World today with the remnant of a third eye on top of the head——the Tuatara of New Zealand!

Boiga irregularis

Introduced Rat snake

This snake was first noticed on Guam about 1946, when it was also noticed on Wake Island. It probably came to Guam as a stowaway on a ship, and got ashore hiding in some cargo. It has been called the Philippine rat snake but this particular species doesn't come from the Philippines. (There are other species of Boiga there, though.) It does occur in Sumatra and other areas.

The rat snake is yellow to yellow-brown. It likes to climb trees and sometimes telephone poles.

Sometimes it crosses electrical wires and shorts them, causing a power outage, and dies of shock. Rat snakes as long as 3.3 m have been found on Guam. Most are shorter. Large ones may eat eggs and occasionally small chickens and big rats. Most are medium-size to small, and eat small rodents and insects.

The rat snake is a rear-fang snake and is poison. It isn't very dangerous to humans because it doesn't have front fangs to inject its poison. It has to chew awhile to break the skin and let the poison ooze in. People just don't stand around and let that happen. Besides, the rat snake, like most wild animals, is generally afraid of people. It won't bother you if you don't bother, corner or surprise it. The rat snake's poison is effective in killing rats. After the rats die, the snake swallows them whole. When it swallows big things, the bones in its jaws come apart. Then its mouth can open very wide. After a big rat is swallowed, you can see the bump where the rat is being digested in the snake's stomach.

Carlia fuscum

Indigenous — Four-fingered brown skink

C. fuscum is a fairly large brown skink (about 12 cm total), that likes to live in more open areas like savanna, old fields and roadsides. You'll see it darting in and out of the edge of the bushes along the road or around junk piles. See if you can catch one. It won't hurt you. Don't you hurt it either. Hold it up so that the sunlight reflects off its back. Are its scales smooth? Do you think their structure has anything to do with the beautiful copper sheen when light hits them? Look at C. fuscum from the side. See if he'll go to sleep or blink. There's a special 'window' in the lower eyelid.

Emoia caeruleocauda

Indigenous — Blue-tailed skink

If you are in an old field with trees and shade, or along a roadside through a forest area,

you'll see lots of blue-tailed skinks. The best way to watch them is to just sit quietly and watch. You may also lay a smelly piece of food next to you to attract insects and skinks. Put it on your leg and they'll walk on you!

Blue-tailed skinks have 3 gold lines down their backs. These lines are brightest on the smaller lizards. You'll also see some larger ones with dull lines and brown tails. These are the adults.

Sit and watch and you'll see lots of interesting behavior as they catch insects and chase each other. They also wave their arms around sometimes.

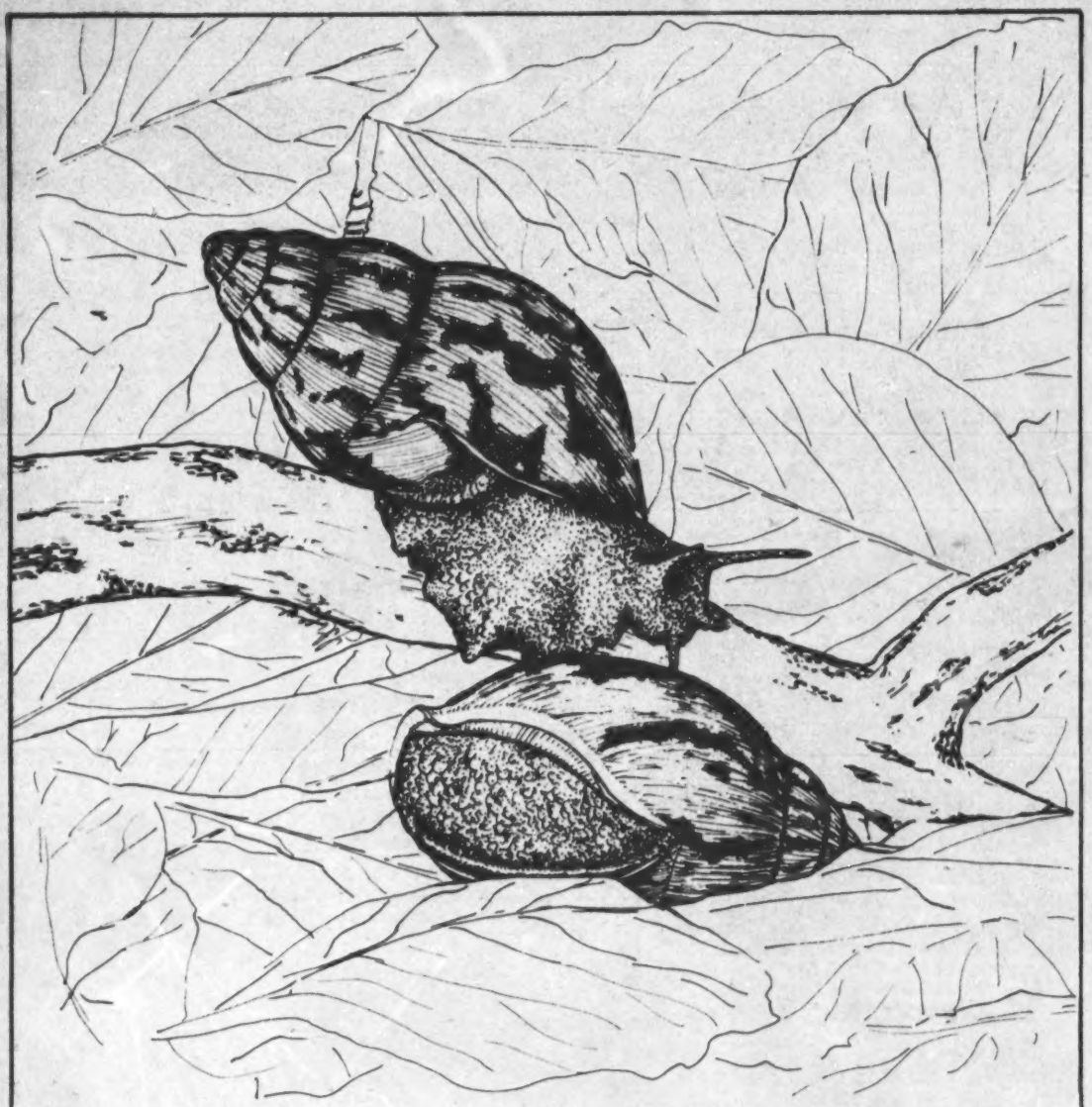
Frogs On Guam

In 1968 a tiny green tree frog was found at Guam International Airport. About a month later, I found specimens in the jungle below the Airport. Since, specimens have been found in other areas of Guam. No one had ever reported this frog from Guam before. It seems to be a new introduction. Guam seems to suit it and it is spreading.

Exercise XV

Listen, Seek, Find...

See if there are frogs where you live. The best way to find one is to listen for it at night. It has a whistle-like call. Once you've heard it, try to find it with a flashlight. It's bright green and beautiful. It has round tips on its toes that adhere to twigs and leaves so it can hop and walk around in trees. Don't forget to look for it there. If you find a frog, bring it to show the class. Then take it back to where you found it. If you don't find a frog, write down in your notebook the things you did hear and see.



Achatina fulica

Introduced Akaleha', the African snail

The African snail is a great traveler and has gotten to many countries uninvited. It has the most important equipment for being an invader. It can really reproduce fast! Besides being able to lay lots of eggs, the African snail is hermaphroditic. That is, each one has both male and female organs and there don't have to be two to mate and produce eggs. They do mate, though. Then both go off and lay eggs!

African snails lay lots of tiny yellow eggs with hard shells that look something like miniature chicken eggs. You can find them under debris on the ground, often buried at the base of a clump of grass or under a board that's been lying on the ground for awhile.

African snails eat by radulating their food. That is, they sort of lick at it with a file-like tongue. It's very effective. You can feel this sharp little radula if you have the patience to let a snail crawl on your hand and radulate your skin a little. It won't hurt you but you'll be surprised that such a soft animal has such a hard little tongue. You may be able to see where it has roughed up your skin some.

These snails eat all sorts of vegetable material. They really like the tender vegetables that people like. Farmers hate them. They fence their gardens from snails and do all sorts of things to get rid of them including setting out poison bait. Some people even leave pans of beer for them to drink! Collecting snails around the garden helps but it has to be done over again once in a while. Collected snails can be left to decompose in a drum or can of water. They make a smelly but good fertilizer.

Exercise XVI

African Snails

a) Despite their being pests, African snails are interesting creatures. Perhaps you've seen them migrating across a road (or heard them being crushed under the car tires). Where are they going? How come they're all going in the same direction? Are they going upwind, downwind, towards the sea, inland, east, west, north or south??? See what you can find out. By doing Exercise XIV with them you might also see if the snails around your yard are residents of the area or just moving through.

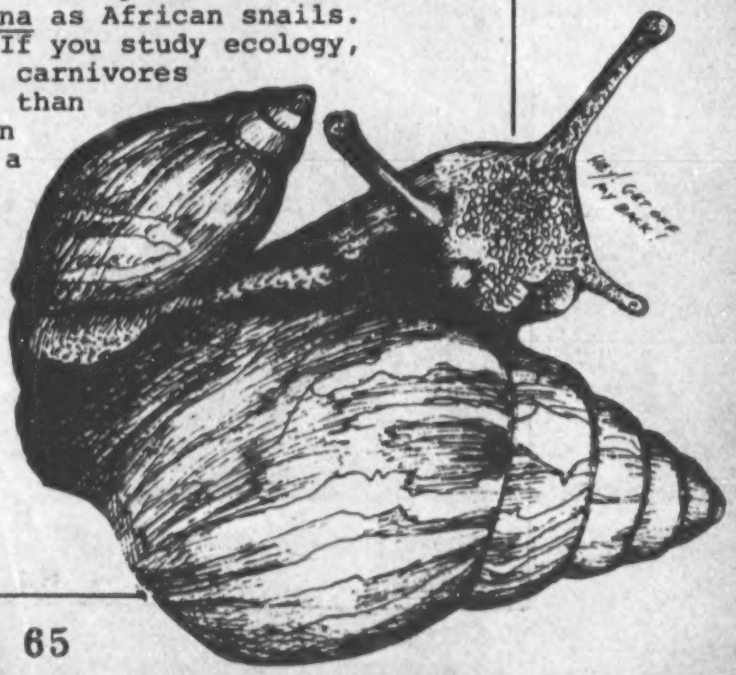
b) Sometimes, especially during dry spells, African snails become inactive. They close up the opening of their shells with a grey, paper-like door of dried mucus. Then they just 'sit' there. If you find some like this, mark them. Leave

several where they are, as they are. Sprinkle water around several others. Put food around others. Peel out the door on several and see if they wake up or if they just reseal their shells. Perhaps you can think of other things to try. Keep notes on how long they stay inactive, and what wakes them up.

c) Find some snail eggs and put a little screen cage around the nest. See how long it takes for the little snails to hatch out. Draw the baby snails and an adult snail in your notebook.

d) Every once in a while, you'll find a really big African snail shell. These were a lot more common in the old days than they are now. Why not hold a contest to see who can bring the biggest shell to class!

People would like to find an enemy of African snails. In Hawaii, the snails' biggest enemy seems to be a sickness which kills them off. Here on Guam, two 'cannibal' snails of the genera Euglandina and Gonaxis have been introduced. The round one, Gonaxis, hasn't done too well, but the long pink one, Euglandina, has spread to many parts of Guam. It was introduced to eat the African snails. When these are gone, it is supposed to eat its own kind. Then we would be rid of both snails. The numbers of African snails on Guam did seem to decrease in recent years but we don't really know if this has been due to the cannibal snail. One University of Guam ecology class set up an experimental plot in a burnt-over savanna and counted all the African snail and Euglandina shells in the plot. There were almost as many Euglandina as African snails. That's not supposed to be! If you study ecology, you learn that the number of carnivores is supposed to be much lower than the number of their prey. In this case, there were almost a many carnivores (Euglandina) as prey (African snails). Something's going on! Maybe the cannibal snail isn't very good at killing African snails. Perhaps it just eats some of the snail, not killing it, but leaving it to regenerate the part that was eaten to become another meal another day!



African snails may also be used for animal food or even people food, although some snail meat, like that of some other animals, may be harmful if eaten raw. Dr. Lambert and other authorities say that, like the meat of other animals, it is perfectly safe to eat if cooked.

One Frenchman visiting Guam suggested that people collect African snails to eat. They're high in protein and to some people they're a delicacy! Here's a way to prepare them:

African Snail Recipe

First you catch your snails – lots of 'em!

Keep them in a cool place, don't feed them for 4-5 days, rinse well once each day.

On the day, rinse 'em, mix in salt, leave ½ hour.

Rinse off salt, clean in lots of running water.

Place in boiling water, boil for 20 minutes.

Prepare stuffing of butter, chopped parsley, garlic, salt and pepper.

Remove snails from shells while still hot.

Discard stomach and intestines, keep only foot (the biggest part).

Rinse foot, cook gently about 2 hours with salt, pepper and other spices to taste.

Clean and drain shells; put snails back into them.

Push 1 tsp. of stuffing into each shell.

Bake in preheated oven until brown.

Guam's Rodents and the Shrew

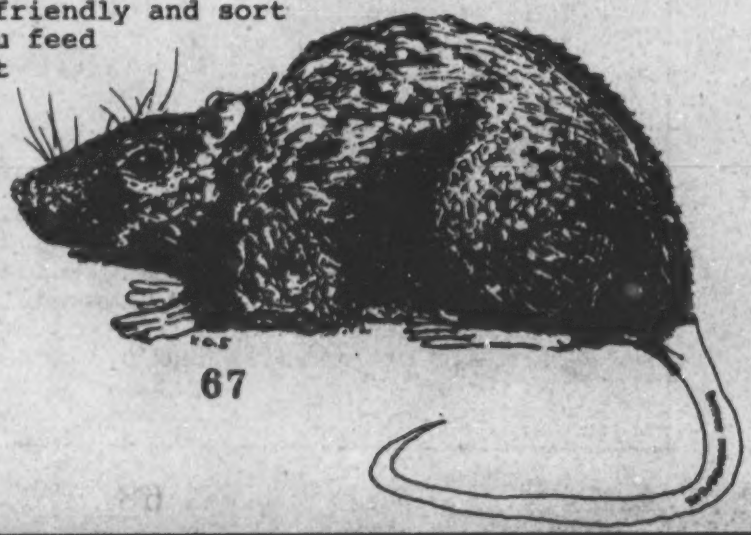
Mus musculus	The house mouse
Rattus exulans	The Polynesian rat
Rattus rattus	The roof rat
Rattus norvegicus	The Norway rat
Suncus murinus	The house shrew

Guam's rodents and shrew are very interesting, so let's introduce them as you may see some in old fields and roadsides.

The house mouse is a tiny cute creature that gets into everything. You can tell it from a baby rat because of its feet. Baby rats of the same size have bigger feet. You can also tell if mice are around by their tiny droppings. There are generally a lot of mice in old fields but they are timid and tend to keep out of sight, especially if rats and shrews are there.

Guam has three kinds of rats. Two have been here a long, long time and the third is a newcomer. The Polynesian rat is the smallest of the three and the wildest. It occurs around houses and also in trees. The roof rat tends to stick around human habitations more. Guam's newest rat resident is the Norway rat. It likes people so much that it is found only where people live. Because it is smart and used to people, it is the biggest pest of the three.

The three species of rats differ in behavior, even when captured and kept in cages. A Polynesian rat remains pretty wild and may try to bite you through the cage when you feed it. A roof rat just gets sort of lazy and not very interesting. A Norway rat gets friendly and sort of gurgles when you feed it. The Norway rat and the white rats used in labs are the same species. They can be tamed into pets, especially if you start with baby rats.



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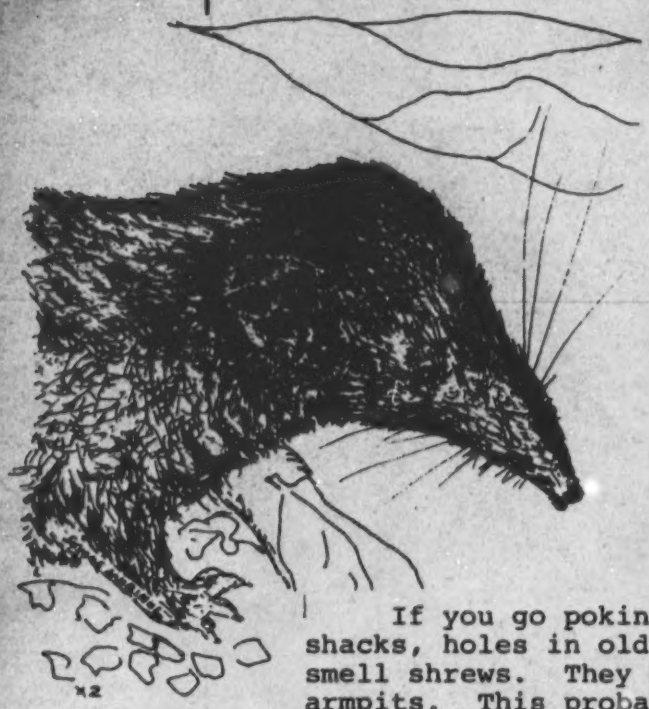


The Asian house shrew or musk shrew is a new animal on Guam, first noticed in the early '50's. It is equipped to be an invader because it eats lots of things and is very aggressive. You can tell the shrew from Guam's rodents right away because of its long nose and flat way of scurrying along the ground. Some people have named it cha'kan akaleha', the snail rat, from the way it stays close to the ground, or because it may eat snails. Our shrew is one of the largest species of shrews. Most others are tiny secretive creatures.

If you go poking around in corners of old shacks, holes in old tree trunks, etc., you may smell shrews. They have scent glands behind their armpits. This probably helps them establish territories.

If you get a shrew out into the open, it runs around frantically with excited squeaks. If you try to frighten it, it may rear back to defend itself. Shrews are ferocious little animals with a very high metabolic rate (speed of living), and have to eat an awful lot just to keep themselves going.

The shrews on Guam molt once in awhile. Patches of hair come out and after awhile a sleek new coat grows back. Sometimes they lose all their hair at once. If you think that shrews are pretty funny-looking to begin with, with those long noses and beady eyes, just wait until you see a naked one!

Rallus owstoni — Ko'ko', Guam rail

Ko'ko' is an only-on-Guam bird. A great many years ago, a bird like the ko'ko' came to Guam, probably from the Philippines or New Guinea way. Over the years it changed little by little until it came to be the ko'ko' of today, different from all other rails and all other birds in the World.

You can see the Guam rail now and then darting across roads and into the bushes. Some people call it a roadrunner because of the way it runs with its neck stretched out in front. The roadrunner is a very different kind of bird, and is not found on Guam.

The ko'ko' is often seen along roads because, like many birds, it likes edges, and because it can find lots of food like crushed snails on the road.

Ko'ko' is an interesting bird. It has at least several calls, a screech-like call and a drum-like sound. If you spend time in the boondocks, you can often hear groups of ko'ko' calling together in the morning and especially in the late afternoon.

The Guam rail makes a simple nest of twigs and grass on the ground in the bushes and generally lays 2 speckled eggs. The chicks are black and downy (fluffy) and look something like chicken chicks.

Ko'ko' is afraid of people and noisy places, but doesn't mind quiet ones. He may join the flock of chickens at the ranch, and even come into a boondock house.

The rail has lots of enemies. One is the monitor lizard, hilitai. Stories tell how ko'ko' and hilitai became enemies: Back in the days when all animals were friends, ko'ko' painted bright spots all over sleeping hilitai. When hilitai woke up and saw his reflection in the water, he became angry and started chasing ko'ko'. You can see him still chasing ko'ko today!

Monitors do eat ko'ko' eggs and probably also the birds, but rails have even worse enemies nowadays. These include many introduced animals like pigs that may root up their nests, dogs, cats, rats, the rat snake (which likes eggs too), and people. Since ko'ko' can't fly, he has a hart time escaping. Some people have trained dogs to catch ko'ko'. Ko'ko's biggest enemy is probably the bulldozer that goes around removing forests and even old fields and clearing protective bushes—— ko'ko's homes along roadsides.

Because rails nest right on the ground, they are bothered a lot by many animals. Mama ko'ko' tries to protect her nest, and she can really put on a ferocious show to try to drive enemies away. Normally ko'ko' would run from enemies like dogs, cats and people, but when she has a nest she stays. She holds her wings out down at her sides, puffs out her feathers and walks shaking from side to side and makes brave lunges like she's attacking.

With such spirit the Guam rail deserves a place on Guam! Let's hope that there will always be some boondocks and tall old fields around for this remarkable bird.

Appendix

Suggested Materials

Notebook and pencil; shovel or trowel; See box (magnifier); seed bed (boxes, cans); plant press (2 pieces of wood 30 cm x 45 cm, corrugated cardboards, newspaper, straps or ropes); plant dryer or oven or light bulbs or fan; glue, cardboard or heavy paper; packing crate or building; maximum-minimum and wet bulb-dry bulb thermometers; wind vane or magnetic compass; stakes and string; nets or nooses or bottles; 2 identical aquaria; fingernail or white shoe polish or spray paint; small mesh screen cage.

A Packing Crate Lab

Working outside is fun. An old packing crate provides an inexpensive indoor-outdoor lab that will allow you to work freely away from the classroom. It will also draw the interest of other students to your class's work. You may want to hold open house at your outdoor lab during the year.

The packing-box lab can be as simple or as elaborate as you want or your school can afford. Just by sitting there it creates seven different habitats: One on each of its four sides, one underneath, one on top and one inside. If there's a fence around it, other students won't disturb your experiments. (You might set your box in a corner of your school so that two sides are already fenced off by your school fence.) If your packing crate has a door you can leave equipment inside. If not, you can put in a locked cabinet. Tables and shelves can easily be installed; also a bin of junk materials like cans and wire and pieces of wood. Hanging planters can be placed on the outsides of the box. Running water can be hosed from a container on the roof. Mounted plant specimens can be taped to the inside walls. Big jars can hold tadpoles here and there. If you really want to get elaborate and daring, you can build a thatched A-frame on top. You can use natural materials, cool the box, and perhaps provide a 'think tank' for groups of students.

There's no end to the things you can do from a packing-case base. Why not start working to get one today! It will make school a lot more enjoyable.

Plants Endemic to Guam and the Marianas

Page in Stone	Scientific Name	Local Guam Name	Kind of Plant	Habitat
355	Aglaia mariannensis	mapuñao	small tree	limestone forest
394	Allophyllus holophyllus	--	shrub	
478	Alyxia torresiana	Nanagu, lodosong lahi	shrub	limestone forest, savanna
248	Artocarpus mariannensis	Dokdok	breadfruit tree	limestone forest
261	Balanophora pentamera	Chilan duhendes	root parasite	limestone forest ground
539	Bikkia mariannensis	Gausali	shrub	limestone cliffs
479	Bleekeria mariannensis	Langite'	tree	limestone forest
155	Bulbophyllum guamense	Siboyas halomtano'	orchid	limestone forest
326	Canavalia megalantha	--	woody vine	
540	Canthium odoratum var. tinianense	--	shrub	limestone cliffs
285	Capparis cordifolia	Atkaparas	shrub	littoral
58	Ceratopteris gaudichaudii	Guafak uhong, umok sensonyan	water fern	freshwater
481	Cerbera dilatata	Chi'uti	small tree	savanna
369	Claoxylon marianum	Panao, kator	small tree	limestone forest
158	Dendrobium guamense	--	orchid	Barrigada Hill forest on dead Artocarpus
255	Dendrocnide latifolia	--	small tree	limestone forest
209	Digitaria spp.	--	grass	coasts
231	Dimeria chloridiformis	--	grass	savanna
488	Dischidia puberula	--	herb	limestone forest
467	Discocalyx megacarpa	Utot	shrub	limestone forest
255	Elatostema calcareum	Tupon ayuyu	herb	limestone forest
256	Elatostema stenophyllum	Tupon ayuyu	herb	limestone forest, river banks
447	Eugenia bryanii	--	shrub	limestone cliffs
448	Eugenia palumbis	Agate'lang	shrub	limestone forest and cliffs

451	Eugenia thompsonii	Atoto	tree	limestone forest
374	Euphorbia gaudichaudii	--	subshrub	
251	Ficus microcarpa var. saffordii	Nunu	Wild fig tree, banyan	limestone forest
252	Ficus prolixa var. subcordata	Nunu	Wild fig tree, banyan	limestone forest
546	Hedyotis albidopunctata	--	low herb	limestone coasts
547	H. foetida var. mariannensis	Paode'do'	shrub	limestone cliffs
548	H. laciniatia	--	herb	savanna
549	H. megalantha	--	herb	savanna
420	Heritiera longipetiolata	Ufa halomtano'	tree	limestone cliffs
493	Ipomoea indica f. albiflora	Halaihai tasi, moonflower	vine	savanna, beach
234	Ishaemum longisetum	--	grass	coasts
471	Jasminum marianum	Banagu	shrub	limestone forest
300	Leucaena insularum var. guamense	--	Guam tangantangan	littoral
381	Macaranga thompsonii	Pengua'	small tree with peltate leaves	limestone forest
469	Maesa sp. nov. (new species)	--	shrub	limestone forest
391	Maytenus thompsonii	Luluhot	shrub	limestone forest
456	Medinilla rosea	Gafos	climbing shrub	savanna
456	Melastoma marianum	Gafo'	shrub	savanna
565	Melothria guamensis	Agaga	climber	limestone shade cliffs
552	Morinda umbellata var. glandulosa	--	woody climber	limestone forest
452	Myrtella bennigseniana	--	shrub	savanna
147	Pandanus fragrans	Kaffo'	Pandanus tree	savanna forest
244	Peperomia mariannensis	potpopot palao'an	herb	limestone forest
387	Phyllanthus saffordii	--	small shrub	savanna
243	Piper guahamense	Pupulon aniti	shrub	limestone forest
97	Potamogeton mariannensis	Marianas pondweed		savanna pools
554	Psychotria hombroniana	Aplok hateng palao'an	small tree	limestone forest

555	Psychotria mariana	Aplok hateng	small tree	limestone forest
555	Psychotria rotensis	--	small tree	riverine forest
27	Saccolabium guamense	--	orchid	
304	Serianthes nelsonii	Hayon lagu	beautiful tree	limestone forest
521	Solanum guamense	Birenghenas halomtano'	shrub	limestone cliffs, savanna
485	Tabernaemontana rotensis	--	tree	limestone forest
163	Taeniophyllum mariannense	Kamuten nanoffe, amot otdon	leafless orchid	all over
345	Tephrosia mariana	--	shrub	
61	Thelypteris maemonensis	--	fern	in woods along streams
560	Timonius nitidus	Maholok layu, sumak ladda	shrub	savanna
277	Tinospora homosepala	--	climbing vine	very rare
428	Xylosma nelsonii	--	small tree	savanna, southern coasts

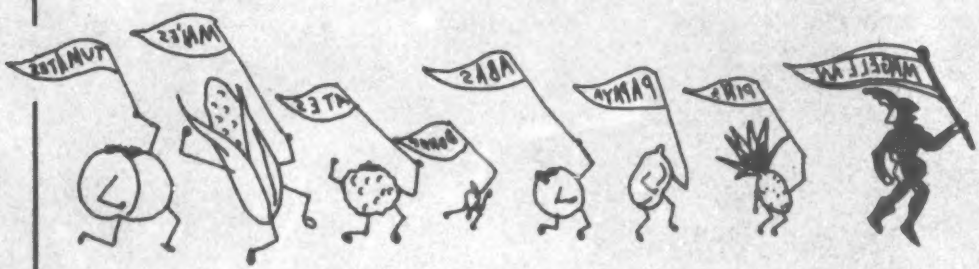
Pre-European Introductions

Page in Stone	Scientific Name	Local and/or Common Name	Kind of Plant
367	Acalypha wilkesiana	Joseph's coat, copperleaf	shrub
296	Adenanthera pavonina	Kolales	tree
136	Areca catechu	Pugua', betelnut	palm tree
248	Artocarpus incisus	Lemmai, breadfruit	tree
186	Bambusa vulgaris	Pi'ao palao'an, bamboo	giant grass
254	Boehmeria tenacissima	Atmahayan, sayafi, rhea	shrub
279	Cananga odorata	Ilang-ilang	tree
112	Canna edulis	Queensland edible canna	herb
353	Citrus aurantifolia	Lemon, lime	tree
138	Cocos nucifera	Niyok, coconut	palm
370	Codiaeum variegatum	Leston puyitos, buena vista, croton, San Francisco	herb

240	Coix lachryma-jobi	Bilen, Job's tears	tall grass
120	Colocasia esculenta	Suni, taro	herb
130	Cordyline fruticosa	Baston San Jose, ti plant	shrub
110	Curcuma domestica	Mango, turmeric	herb
120	Cyrtosperma chamissonis	Baba', giant taro	herb
127	Dioscorea alata	Dagu, yam	vine
128	D. esculenta	Dagu, yam	vine
251	Ficus tinctoria	Hodda, tage'te', dyers' fig	tree
336	Inocarpus edulis	Buoy, Tahitian, Yapese chestnut	tree
491	Ipomoea aquatica	Kangkong	vine
565	Luffa acutangula	Loofah, patola, vegetable sponge	vine
389	Mangifera indica	Mangga, mango	tree
113	Maranta arundinacea	Aruru, sagu, arrowroot	herb
566	Momordica charantia	Atmagosu, bitter melon	vine
289	Moringa oleifera	Maronggai, kutdes, horseradish tree	tree
107	Musa paradisiaca	Chotda, banana	giant herb
107	M. sapientum	Chotda, banana	giant herb
198	Oryza sativa	Fa'i, rice	tall grass
427	Pangium edule	Rau'al, lasret, football fruit	tree
243	Piper betle	Pupulu, betel pepper	vine
459	Polyscias fruticosa	Papua, panax	shrub
461	P. pinnata	Panax	shrub
461	P. scutellaria	Platitos, saucer leaf	shrub
535	Pseuderanthemum carruthersii	--	shrub
238	Saccharum officinarum	Tupu, sugar cane	tall grass
151	Tacca leontopetaloides	Gabgab, arrowroot	herb
111	Zingiber zerumbet	Ginger	herb

Crops Introduced from the Americas by Spaniards

Page in Stone	Scientific Name	Local and/or Common Name	Kind of Plant
106	Ananas comosus	Piña, pineapple	rosette herb
278	Annona muricata	Laguana, soursop	fruit tree
279	A. reticulata	Anonas, custard apple	fruit tree
279	A. squamosa	Ates, sweetsop	fruit tree
515	Capsicum annuum	Donne', chili pepper	herb
429	Carica papaya	Papaya	soft tree
418	Ceiba pentandra	Atgidon Manila, kapok	tree
409	Gossypium barbadense	Atgidon, cotton	shrub
379	Hevea brasiliensis	Tronkon goma, rubber tree	
491	Ipomoea batatas	Kamuti, sweet potatao	creeping vine
564	Lagenaria siceraria	Tagu'a, kalamasa, gourd	vine
518	Lycopersicon esculentum	Tumates, tomato	herb
382	Manihot esculenta	Mendioka, cassava, tapioca	erect shrub
464	Manilkara achras	Chiku, chicle	tree
519	Nicotiana tabacum	Chupa, tobacco	large erect herb
282	Persea americana	Alageta, avocado	fruit tree
454	Psidium guajava	Abas, guava	small tree
163	Vanilla planifolia	Vanilla bean	viny orchid
123	Xanthosoma spp.	Sunen Honolulu, yautia, taro	herb
241	Zea mays	Mai'es, maize, corn	large grass



Introduced American Weeds

The Spanish galleons and other visitors from the New World (Americas) brought at least 52 species of weeds. Here are some of the more familiar ones:

Page in Stone	Scientific Name	Local and/or Common Name	Kind of Plant
296	Acacia farnesiana	Aroma, klu	shrub
268	Amaranthus spinosus	Kilites	herb
487	Asclepias curassavica	Asunsion, milkweed	herb
583	Bidens pilosa	Beggar's tick	herb
533	Blechum brownei	Yetbas babui	herb
324	Calopogonium mucunoides	Akangkang guaka	vine
310	Cassia alata	Take' biha, candlebush	shrub
311	C. spp.	Atmot tumaga' karabao, mumutun sapble, senna	shrubs
205	Cenchrus echinatus	Inifok español, sticker bur	grass
195	Chloris inflata	fingergrass	
576	Conyza bonariensis		herb
328	Crotalaria mucronata	Rattle box	shrub
328	C. quinquefolia	Kaskabeles, rattlepod	herb
592	Elephantopus mollis	Papago' baka	herb
373	Euphorbia cyathophora	Dwarf poinsettia	herb
511	Hyptis capitata	Batunes	subshrub
335	Indigofera suffruticosa	Ani'es, indigo	shrub
494	Ipomoea triloba	Fafgo sabana	twining herb
380	Jatropha curcas	Tuba tuba, physic nut	shrub
299	Leucaena leucocephala	Tangantangan	tree
302	Mimosa pudica	Betguen sosa, sensitive plant	prickly creeper
216	Paspalum spp.		grasses
430	Passiflora foetida	Mediu dia, passionflower	vine
220	Pennisetum setosum	Yellow-tailed grass, very common.	
520	Physalis angulata	Tumates cha'ka	herb
507	Stachytarpheta indica	Laso' katu, false verbena	subshrub
586	Tridax procumbens	Coat-buttons, wild daisy	herb

Acknowledgements

The information in this booklet comes from many sources. Some of the main written ones are listed below. Chamorro names were reviewed or provided by Olympia Q. Camacho and Joe Rivera of the Chamorro Language & Culture Project. My thanks to Stanley Kenrad of Yap for the drawing of the Pandanus doll on page 16, and to L Hotaling for additional drawings and layout.

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The artist at work